8505A
Digital Multimeter

Instruction Manual

FLUKE®

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FLUKE®

P/N 638841
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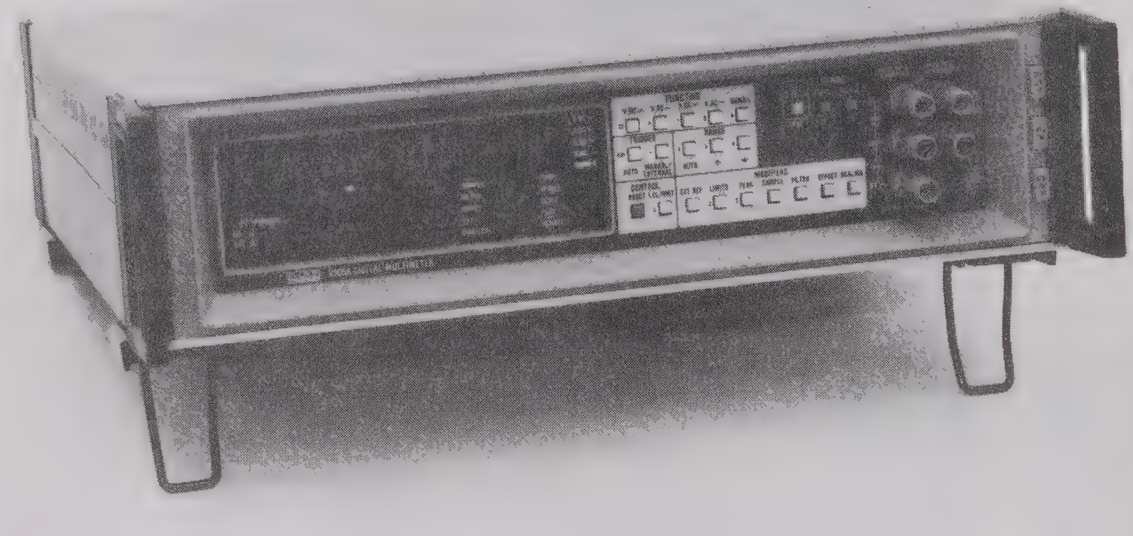


8505A Digital Multimeter

Section 1
Introduction & Specifications

1-1. INTRODUCTION

1-2. This eight-section manual provides comprehensive information for installing, operating and maintaining your Fluke digital multimeter. Complete descriptions and instructions are included for the instrument mainframe, for all modules necessary in making dc volts measurements, and for any optional modules ordered with the instrument. Appropriate sectionalized information is also included with any optional modules subsequently ordered and may be inserted in Section 6.

1-3. DESCRIPTION

1-4. The multimeter features 6-1/2 digit resolution, full annunciation and simplicity of operation. Modular construction, microprocessor control, and a bus structure provide excellent flexibility. Memory programming from the front panel (or through a remote interface) controls all measurement parameters, mathematic operations and special operations. An averaging mode is available to automatically optimize display resolution and stability for each function and range. The standard hardware configuration allows for measurement of dc volts in five ranges with 100 nV resolution on the lowest range. Optional modules are available for ac volts (four ranges), ac or dc current (five ranges), and resistance (eight ranges) in two-wire or four-wire arrangements.

1-5. Modular Construction

1-6. Considerable versatility is realized through unique contruction. All active components are contained in modules which plug into a mainframe motherboard. This module-motherboard mating, combined with bus architecture and microprocessor control, yields both ease of option selection and reduced downtime.

1-7. Microprocessor Control

1-8. All modules function under direct control of a microprocessor based controller. Each module is addressed by the controller as virtual memory. External reference values and offsets can be applied separately, stored in memory, and automatically used as factors in all subsequent readings. Digital filtering utilizes averaged samples for each reading.

1-9. Software Calibration

1-10. The 8505A features microprocessor-controlled calibration of all ranges and functions. Any range can be calibrated using a reference input of any known value from 60% of range to full scale. Software calibration can be performed using front-panel or remote control, allowing recertification without opening the case or removing the multimeter from the system.

1-11. Recirculating Remainder A/D Conversion

1-12. The multimeter adapts Fluke's patented recirculating remainder (R^2) A/D conversion technique to microprocessor control. This combination provides fast, accurate, linear measurements and long-term stability.

1-13. Options and Accessories

1-14. Remote interfaces, ac converters, a current converter, and an ohms converter are among the numerous options and accessories available for use with the multimeter. Refer to Tables 1-1 and 1-2 for complete listings. AC conversion can be accomplished with either the AC Averaging module (Option 01) or the RMS module (Option 09A). Any one of the three Remote Interface modules (Option 05, 06, or 07) can be installed at one time.

1-15. SPECIFICATIONS

1-16. Mainframe specifications with dc volts and dc ratio measurement capability are presented in Table 1-3. Optional function specifications are supplied with the respective option modules and included in Section 6.

Table 1-1. Options

OPTION NO.	NAME	NOTES
01	AC/DC Converter (Averaging)	1, 3
02A	Ohms Converter	
03	Current Shunts	3
05	IEEE Standard 488-1975 Interface	2
06	Bit Serial Asynchronous Interface	2
07	Parallel Interface	2
09A	AC/DC Converter (True RMS)	1, 3

1) Options 01 and 09A cannot be installed simultaneously.

2) Only one of Options 05, 06, and 07 can be installed at any time.

3) For the ac portion of Option 03 to operate, either Option 01 or 09A must be installed.

Table 1-2. Accessories

MODEL OR PART NO.	NAME
M04-205-600	5¼-inch Rack Adapter
M00-260-610	18-inch Rack Slides
M00-280-610	24-inch Rack Slides
80K-6	High Voltage Probe
80K-40	High Voltage Probe
83RF	High Frequency Probe
85RF	High Frequency Probe
Y8001	IEEE Std. Cable, 1 Meter Length
Y8002	IEEE Std. Cable, 2 Meter Length
Y8003	IEEE Std. Cable, 4 Meter Length
MIS-7011K*	Extender Card
MIS-7190K*	Static Controller
MIS-7191K*	Test Module
MIS-7013K*	Bus Interconnect and Monitor

*For use during service or repair.

Table 1-3. Specifications

GENERAL SPECIFICATIONS	
Dimensions	10.8 cm High x 43.2 cm Wide x 42.5 cm Long (4.25 in High x 17 in Wide x 16.75 in Long) (See Figure 1-1)
Weight	
BASIC	10 kg (22 lbs)
FULLY LOADED	12 kg (26 lbs)
Operating Power	
VOLTAGE	100V ac, 120V ac, 220V ac, or 240V ac (±10%)
BASIC INSTRUMENT POWER	12 watts
FULLY LOADED POWER	24 watts
FREQUENCY	47 Hz to 63 Hz (400 Hz available on request)
Warm-Up	2 hours to rate accuracy
Shock and Vibration	Meets requirements of MIL-T-28800 for type III, class 5, style E equipment.
Temperature Range	
OPERATING	0°C to 50°C
NON-OPERATING	-40°C to 70°C
Humidity Range	
0°C TO 18°C	80% RH
18°C TO 40°C	75% RH
40°C TO 50°C	45% RH
Maximum Terminal Voltage	
LO TO GUARD	127V rms
GUARD TO CHASSIS	500V rms
HI SENSE TO HI SOURCE	127V rms
LO SENSE TO LO SOURCE	127V rms
HI SENSE TO LO SENSE	1000V rms or 1200V dc
HI SOURCE TO LO SOURCE	280V rms

Table 1-3. Specifications (cont)

DC VOLTAGE

Input Characteristics

RANGE	FULL SCALE 6½ DIGITS	RESOLUTION		INPUT RESISTANCE
		7½ DIGITS*	6½ DIGITS	
100 mV	200.0000 mV	—	100 nV	>10,000MΩ
1V	2.000000V	—	1 μV	>10,000MΩ
10V	20.00000V	1 μV	10 μV	>10,000MΩ
100V	128.0000V	—	100 μV	10MΩ
1000V	1200.000V	—	1 mV	10MΩ

*7½-digit resolution: In AVG operating mode.

Accuracy

DC VOLTS: ±(% of Reading + Number of Counts)

RANGE	24-HOUR 23°C ±1°C[1]		90-DAY 23°C ±5°C	
	OPERATING MODE		OPERATING MODE	
	NORM	AVG	NORM	AVG[3]
100 mV	0.0018 + 15	0.0010 + 8	0.0025 + 40	0.0020 + 8
1V	0.0008 + 7	0.0005 + 4	0.0015 + 8	0.0012 + 6
10V	0.0006 or 6*	0.0005 or 50[2]*	0.0010 + 8	0.0008 + 60[2]
100V	0.0010 + 6	0.0005 + 5	0.0018 + 8	0.0015 + 6
1000V	0.0008 + 6	0.0005 + 5	0.0018 + 8	0.0015 + 6

*Whichever is greater

>90-Day: 23°C ±5°C

Add to the 90-day specification per month the following % of Reading and Number of Counts.

RANGE	OPERATING MODE	
	NORM	AVG[3]
100 mV	0.00017 + 5.6	0.0001 + 0.1
1V	0.0001 + 0.1	0.0001 + 0.1
10V	0.0001 + 0.1	0.00008 + 1[2]
100V	0.00013 + 0.1	0.0001 + 0.1
1000V	0.00013 + 0.1	0.0001 + 0.1

NOTES:

[1] Relative to calibration standards, 4-hour warm-up, within 1 hour of dc zero. After software calibration, add the following to the 24 hour accuracy specification:

TIME SINCE INTERNAL (HARDWARE) CALIBRATION	NUMBER OF COUNTS*
<30 Days	0
<90 Days	1
<1 Year	2
>1 Year	3

*With 6½-digit display. For 7½-digits, multiply Number of Counts by 10.

[2] 7½-digit mode of operation.

[3] After 4-hour warm-up, within 1 hour of dc zero.

Table 1-3. Specifications (cont)

Operating Characteristics

TEMPERATURE COEFFICIENT: ±(% of Reading + Number of Counts)/°C

RANGE	0°C TO 18°C AND 28°C TO 50°C
100 mV	0.0003 + 5
1V	0.0003 + 1
10V	0.0002 + 0.5*
100V	0.0003 + 1
1000V	0.0003 + 0.5

*Multiply Number of Counts by 10 for AVG operating mode (7½-digit).

INPUT BIAS CURRENT

AT TIME OF ADJUSTMENT	1-YEAR 23°C ±1°C	TEMPERATURE COEFFICIENT
<±5 pA	<±30 pA	<±1 pA/°C

ZERO STABILITY .... Less than 5 μV for 90 days after a four-hour warm-up. Front panel pushbutton zero is provided for permanent storage of a zero correction for each range. Zero may be turned off at any time.

MAXIMUM INPUT VOLTAGE .... ±1200V dc or 1000V rms ac to 60 Hz, or 1400V peak above 60 Hz may be applied continuously to any dc range without permanent damage. Maximum common mode rate of voltage rise is 1000V / μsec.

ANALOG SETTLING TIME

FILTER MODE	FILTER COMMAND	TO 0.01% OF STEP CHANGE	TO 0.001% OF STEP CHANGE
Bypassed	F1	2 ms	20 ms
Fast	F0 or F3	40 ms	50 ms
Slow	F or F2	400 ms	500 ms

DIGITIZING TIME

Line Synchronous .... For 2^0 to 2^{17} samples per reading digitizing time is from 4 ms to 9 minutes 6 seconds using a 60 Hz ac line with times increasing 20% using a 50 Hz ac line. Selectable in 18 binary steps.

Line Asynchronous .... 2 ms. (In 3 byte binary mode with dc zero, offset, limits and calibration factors turned off.)

NOISE REJECTION

Normal Mode Rejection

LINE FREQUENCY	FILTER MODE	4 SAMPLES/ READING	32 SAMPLES/ READING	128 SAMPLES/ READING
50 hertz	Fast	60 dB	70 dB	75 dB
50 hertz	Slow	85 dB	90 dB	95 dB
60 hertz	Fast	60 dB	70 dB	75 dB
60 hertz	Slow	90 dB	95 dB	100 dB

Common Mode Rejection .... 160 dB at 60 hertz with 1 kΩ in series with either lead, and 4 samples or more per reading. Greater than or equal to 100 dB with less than 4 samples per reading.

Table 1-3. Specifications (cont)

DC RATIO

Accuracy

EXTERNAL REFERENCE VOLTAGE*	ACCURACY[1]
±20V to ±40V	±(A + B + 0.001%)
$\pm V_{min}$ to ±20V	$\pm(A + B + (0.02\% / \lvert V_{xref} \rvert))$

*Maximum External Reference Voltage = ±40V between External Reference HI and LO terminals, providing neither terminal is greater than ±20V relative to the Sense LO or Ohms Guard[2] terminals.

Operating Characteristics

INPUT IMPEDANCE .... External Reference HI or LO >10,000 MΩ relative to Ohms Guard[2] or Sense LO.

BIAS CURRENT .... External Reference HI or LO relative to Ohms Guard[2] or Sense LO <5 nA.

SOURCE IMPEDANCE .... Resistive Unbalance (External Reference HI to LO) <4 kΩ. Total Resistance to Sense LO from either External Reference HI or LO <20 kΩ.

MAXIMUM OVERLOAD VOLTAGE ... ±180V dc or peak ac (relative to Ohms Guard[2] or Sense LO). ±360V dc or peak ac (External Reference HI to LO).

NOISE REJECTION

INPUT TERMINALS	NORMAL MODE	COMMON MODE
Sense	Same as dc volts	Same as dc volts
External Reference	line frequency and 2x line frequency >100 dB	line frequency and 2x line frequency >75 dB

RESPONSE TIME

Analog Settling Time

FILTER MODE	FILTER COMMAND	TO 0.01% OF STEP CHANGE	TO 0.001% OF STEP CHANGE
Bypassed	F1	2 ms	20 ms
Fast	F0 or F3	40 ms	50 ms
Slow	F or F2	400 ms	500 ms

NOTES: (DC Ratio)

[1] A = 10V dc range accuracy for the appropriate period of time.

B = Input signal function and range accuracy for the appropriate period of time.

V_{min} = Minimum allowable External Reference Voltage = ±0.0001V, or $V_{input} / 10^9$ (whichever is greater).
$\lvert V_{xref} \rvert$ = Absolute value of the External Reference Voltage

[2] Ohms Guard is available through the rear input.

Table 1-3. Specifications (cont)

DC RATIO (cont)	
Operating Characteristics (cont)	
Digitizing Time	For 2^0 to 2^{17} samples per reading digitizing time is from 196 ms to 9 minutes 6 seconds using a 60 Hz ac line with times increasing 20% using a 50 Hz ac line. Selectable in 18 binary steps.
MAXIMUM RATIO DISPLAY	+1.00000 E±9
EXTERNAL TRIGGER INPUT	
Polarity	May be wired internally for either rising or falling edge. Factory wired for falling edge.
High Level	+4.3V (minimum)
Low Level	+0.7V (maximum)
Pulse Width	10 μs (minimum)
Connector	BNC with the outer shell at interface common
Maximum Input	±30V
Maximum Shell to Ground Voltage	±30V
SCAN ADVANCE OUTPUT	
Polarity	Positive
High Level	>+4V (TTL High)
Low Level	<+0.7V (TTL Low)
Pulse Width	3 μs (minimum)
Connector	BNC with the outer shell at interface common
Maximum Shell to Ground Voltage	±30V

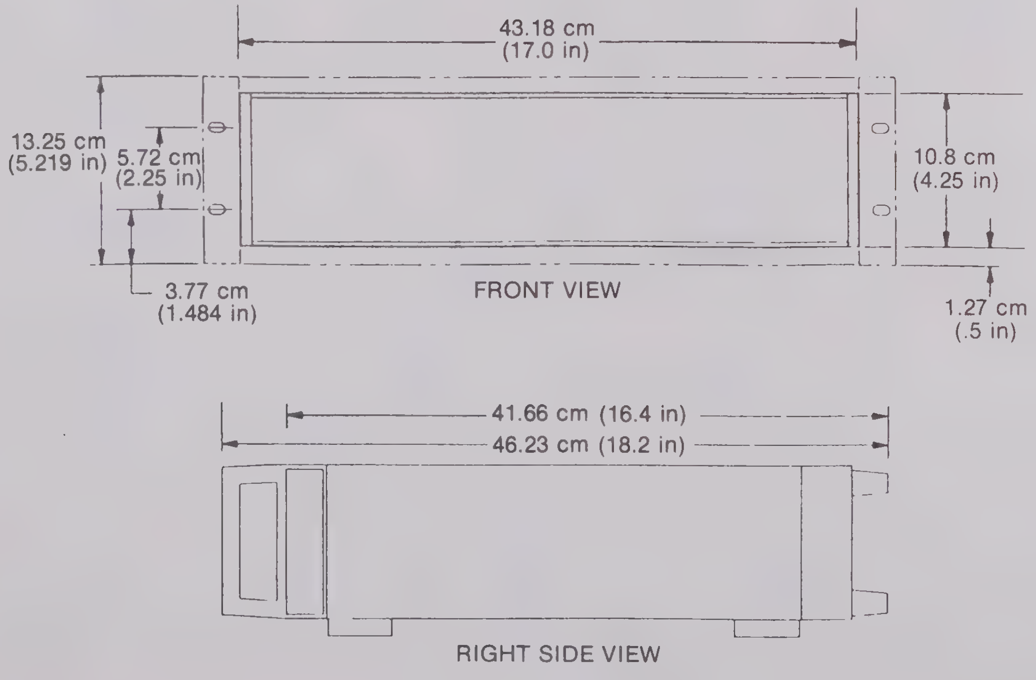

43.18 cm
(17.0 in)
13.25 cm
(5.219 in)
5.72 cm
(2.25 in)
10.8 cm
(4.25 in)
3.77 cm
(1.484 in)
FRONT VIEW
1.27 cm
(.5 in)
41.66 cm (16.4 in)
46.23 cm (18.2 in)
RIGHT SIDE VIEW

Figure 1-1. Dimension Drawing

Section 2
Operating Instructions

2-1. INTRODUCTION

2-2. Installation and operation of the multimeter are explained in this section. These instructions should be read thoroughly prior to multimeter operation. Once a familiarization with the instrument is achieved, parts of this section will serve as a quick reference. Explanations and applications are provided for all standard functions and operations. Should any difficulties arise, contact your nearest Fluke Sales Representative (listed in Section 7) or the John Fluke Mfg. Co., Inc.; P.O. Box C9090; Everett, WA. 98206; tel. (206) 342-6300).

2-3. SHIPPING INFORMATION

2-4. The multimeter is packaged and shipped in a foam-packed container. Upon receipt of the instrument, a thorough inspection should be made to reveal any possible shipping damage. Special instructions for inspection and claims are included with the shipping container.

2-5. If reshipment is necessary, the original container should be used. If the original container is not available, a new container can be obtained from John Fluke Mfg. Co., Inc. Please reference the instrument model number when requesting a new shipping container.

2-6. INSTALLATION

2-7. Non-marring feet and a tilt-down bail arrangement are installed on the instrument for field or bench use. A rack-mounting kit and rack slides are available for use with the standard 19-inch equipment racks. Information regarding installation and rack-mounting accessories is contained in Section 6.

2-8. The multimeter operates from 100, 120, 220, or 240V ac (±10%) at 50 or 60 Hz. Line voltage selection must be verified before the power cord is connected. This verification procedure is explained in Section 4.

WARNING

TO AVOID ELECTRICAL SHOCK, PROPERLY GROUND THE CHASSIS. A GROUND CONNECTION IS PROVIDED ON THE THREE-PRONG POWER CONNECTOR. IF PROPER GROUND IN YOUR POWER SYSTEM IS IN DOUBT, MAKE A SEPARATE GROUND CONNECTION TO THE REAR PANEL CHASSIS BINDING POST. OTHERWISE, THE POSSIBILITY OF ELECTRICAL SHOCK MAY EXIST IF HIGH VOLTAGE IS MEASURED WITH THE LEADS REVERSED (INPUT HI GROUNDED).

2-9. OPERATING FEATURES

2-10. Front and rear panel features are illustrated in Figure 2-1 and described in Table 2-1. Use this information for initial familiarization with the multimeter. A full explanation of all features is presented later in this section.

2-11. OPERATING NOTES

2-12. Input Power

2-13. A binding post on the rear panel has been provided as an earth ground connection. Line voltage selection (100, 120, 220, or 240V ac) is explained in Section 4. With the exception of proportionately slower reading rates and filter time-outs, operation at 50 Hz is identical to that at 60 Hz.

2-14. The line fuse (0.5A MDL Slow Blow for 100 or 120V ac, or 0.25 MDL Slow Blow for 220 or 240V ac) is located on the lower right side of the rear panel (in the heat sink). The current and ohms protection fuse (1.5A AGC) is located in the lower right-hand corner of the front panel for front input connections and on the left side of the rear panel (as seen from the rear) for rear input connections. Refer to Fuse Replacement in Section 4 before replacing any fuse.

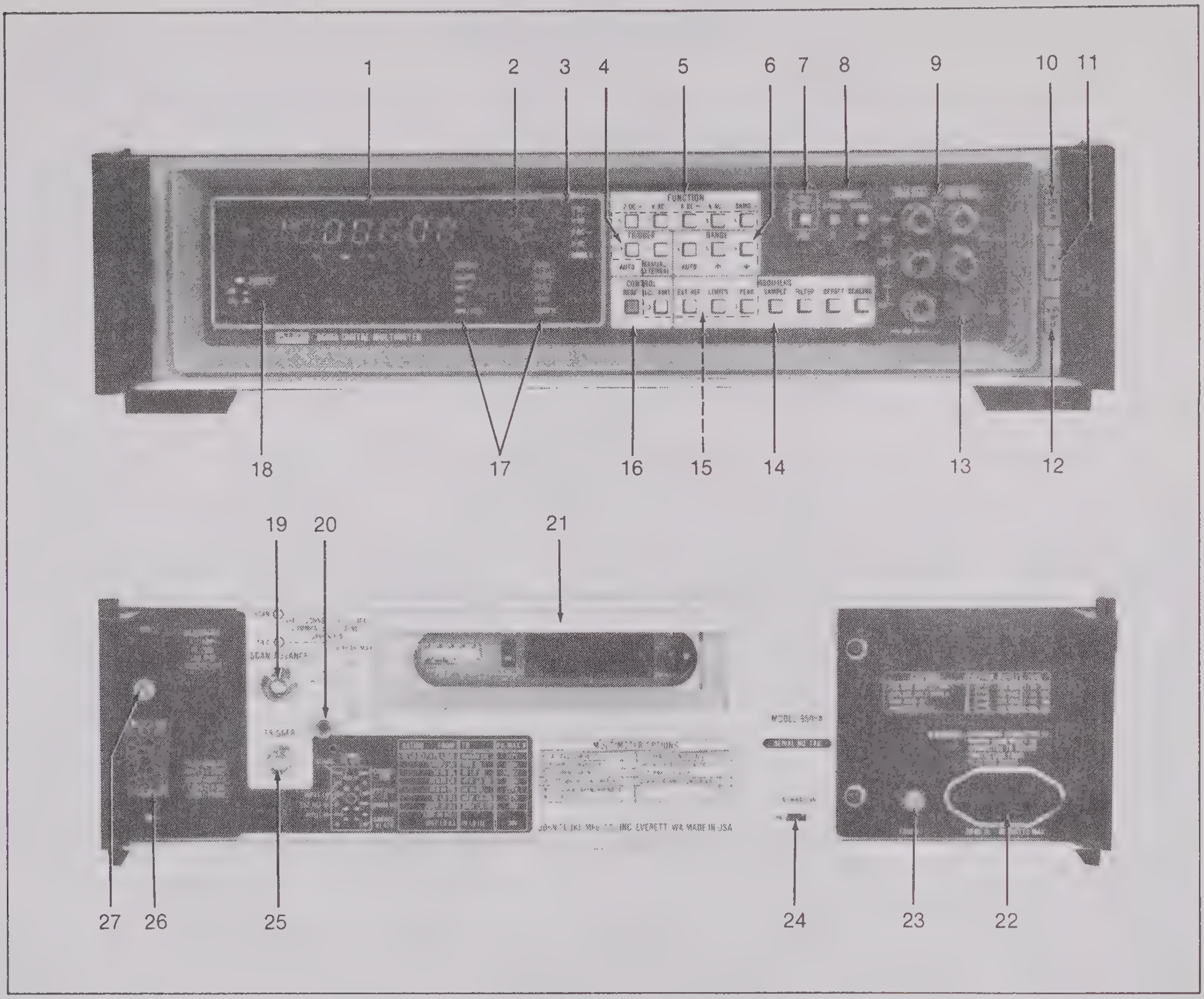


Figure 2-1. Controls, Indicators, and Connectors

Table 2-1. Controls, Indicators, and Connectors

ITEM	NAME	DESCRIPTION
1	Mantissa Field	Displays 5½, 6½ or 7½ digits with polarity and decimal point. Also displays errors and warnings, prompts, numerics, recalled values, and limits indications.
2	Exponent Field	Polarity and value of exponent shown for engineering notation of display value. In Averaging or Calibration mode, the exponent may be used as an extra digit of resolution.
3	Function Annunciators	Annunciator lights to indicate function selection. V DC and V AC annunciators will both light when respective functions are simultaneously selected and the RMS Converter is installed.
4	TRIGGER Push Buttons	TRIGGER push buttons used to select continuous (AUTO) or individual (MANUAL/EXTERNAL) measurement triggers.

Table 2-1. Controls, Indicators, and Connectors (cont)

ITEM	NAME	DESCRIPTION
5	FUNCTION Push Buttons	Used to select any of six measurement functions: voltage (V DC, V AC, or V DC and V AC), current (A DC or A AC), or resistance (OHMS).
6	RANGE Push Buttons	AUTO toggles into/out of Autoranging mode, changing range only when necessary. The up/down buttons exit Autoranging and increase/decrease one range with first use, step up/down one range with each additional use.
7	ZERO Push Button	Used to toggle into/out of the Zero mode (V DC or OHMS only). A new zero value is stored each time the mode is entered. This value is applied to the selected range and to all higher ranges within the same function. Also used to recall zero values. Refer to text for use with Calibration Memory.
8	MEMORY Push Buttons	STORE is used to initiate memory entry for displayed values or numeric entries. RECALL commands display of a memory value. HI and LO are used when storing or recalling limits, or when recalling peak values.
	Average Push Button	AVG toggles into/out of Averaging mode.
9	Input Terminals	Measurement connection terminals.
10	Guard Selector	GUARD is connected to SENSE LO when disengaged (out); GUARD is floated to allow external connection when engaged (in).
11	Ohms Selector	Push in for 4-wire ohms measurement using OHMS SENSE (HI, LO) and OHMS SOURCE (HI, LO) terminals. Push again to disengage for 2-wire ohms measurements using OHMS SENSE (HI, LO) terminals.
12	Rear Input Selector	Push in to connect rear analog input terminals and disconnect front terminals. Push again to disengage, reconnecting front terminals and disconnecting rear terminals. Position of the switch can be sensed remotely.
13	Current/Ohms Fuse	Use AGC 1.5A.
14	MODIFIERS Push Buttons	SAMPLE and FILTER modify the manner in which a reading is taken (measurement parameters). EXT REF, OFFSET, and SCALING modify the reading value (mathematic operations). LIMITS and PEAK modify the usage of the measurement value (special operations).
15	Numeric Entry Push Buttons	When enabled by initially pushing the STORE button, these push buttons can be used to enter numerics, exponents and related polarity signs.
16	CONTROL Push Buttons	RESET initiates a power-up reset. LCL/RMT usage depends on the remote interface in use: a. If the IEEE Interface (-05) is used, LCL/RMT toggles from remote to local, but not from local to remote. b. If the Bit Serial (-06) or Parallel (-07) Interface is used, LCL/RMT toggles between local and remote.

Table 2-1. Controls, Indicators, and Connectors (cont)

ITEM	NAME	DESCRIPTION
17	Status Annunciators	SAMPLE flashes to show a new reading in progress. FILTER lights whenever slow filter is selected. AUTO lights for Autoranging. EXT lights when External Reference is enabled (disables Scaling). AVG/CAL lights (steady) for Averaging or flashes for Calibration mode. ZERO lights when a V DC or OHMS zero correction value is in use. OFFSET lights when Offset mode is enabled. SCALE lights when Scaling mode is selected (disables Ext Ref). PEAK lights when Peak mode is enabled. REMOTE lights when the multimeter is controlled through a remote interface.
18	POWER Switch	Push ON/push OFF. The Calibration switch (item 24) must be off before cycling power on or off.
19	Scan Advance Output	TTL compatible output signals to external scanner (50-ohm output impedance).
20	Chassis Ground	Binding post for ground connections.
21	Remote Interface Access Port	Connector on optional remote interface module accessible here.
22	Power Connector	Three-prong connector accepting line cord with ground wire.
23	Line Fuse	Use ½A Slow Blow for 100 or 120V ac, ¼A Slow Blow for 220 or 240V ac. Refer to Fuse Replacement in Section 4.
24	Calibration Switch	Activates Calibration mode (AVG/CAL) annunciator flashes).
25	External Trigger Input	Enabled by front panel MANUAL/EXTERNAL push button.
26	Rear Analog Input Connection	Alternate connections for all front panel inputs — enabled when Rear Input Selector on front panel is pushed in. EXT REF HI and LO inputs are also included, but are not switched by the Rear Input Selector.
27	Rear Input Fuse	Use AGC 1.5A.

2-15. Required Hardware

2-16. The multimeter must be equipped with the following modules for standard operation (dc volts).

1. Controller (blank display if not installed)
2. Active Filter (Error 2 if not installed)
3. A/D Converter (Error 5 if not installed)
4. Isolator (Error 9 at power-up if not installed)

2-17. Additional modules are necessary when using the multimeter in ac volts, dc current, ac current, or resistance functions or for remote control. Separate modules for averaging ac or rms ac measurements are available: only one of these modules may be installed at one time. If it is necessary to check, install or replace modules, refer to Module Installation and Removal procedures in Section 4.

2-18. An "Error 9" indication appears in the multimeter display whenever an optional function is selected and the respective function module is faulty or missing. At power-up, the multimeter identifies all installed options by displaying "CXXXXXX" ("X" = Option number). An "8" in the exponent display identifies an installed Isolator.

For example, a multimeter configured with the Current Shunts (Option 03) and the IEEE Remote Interface (Option 05) is identified with a power-up display of "C35 8"..

2-19. Power-Up Configuration

2-20. At power initialization, or whenever the RESET button is pushed, the multimeter assumes the power-up configuration. Basically, the instrument assumes the V DC function with all modes and values disabled. The power-up configuration is fully defined in Table 2-2.

2-21. Display

2-22. MEASUREMENT READING

2-23. The measurement display consists of mantissa and exponent fields. The mantissa presents polarity, 5-1/2, 6-1/2, or 7-1/2 digit resolution (range and function dependent) and automatic decimal placement. In addition, the mantissa displays numeric storing entries, recalled values, error and warning information, and interactive programming information (prompts). Decimal point positions are labeled (1, 10, 100, 1k) to correspond with range settings (as defined in Figure 2-3).

2-24. When very large or small readings are displayed, the exponent field is also used to maintain maximum resolution. A negative or positive exponent field polarity indicates multiplication of the mantissa by the displayed power of ten (–3 means .001, +3 means 1000). Exponent values of –6, –3, +3, or +6 are available for displayed readings. Additional exponents of –9 and +9 are available for offset and scaling numeric entries.

2-25. When the Averaging mode is selected, the exponent may serve as an additional digit of resolution. When the Limits mode is selected, the entire measurement display is devoted to an indication of HI, LO, or PASS.

2-26. ANNUNCIATORS

2-27. Any valid function selection causes one of the function annunciators (V DC, V AC, A DC, A AC, OHMS) to light. The V DC annunciator normally lights in the power-up or reset configuration. However, if the DC Signal Conditioner module is faulty or not installed and a functional RMS Converter module is installed, power-up or reset causes the V AC annunciator to light. Two function annunciators (V DC and V AC) light when

Table 2-2. Default Configurations

	POWER-UP OR RESET		SELECTION OF NEW FUNCTION (1)	
	CONDITION	DISPLAY	CONDITION	DISPLAY
Function	DC Volts	V DC on	New Function	VDC,VAC,ADC, AAC or OHMS on
Range	1000V Manual	AUTO off	Autoranging	AUTO on
Trigger	Auto	SAMPLE flashes	Retains Previous Trigger Mode	SAMPLE flashing or off
Filter	F0	FILTER off	Retains Previous Filter Mode (2)	FILTER on or off
Sample	7	SAMPLE flashes	Retains Previous Sample Setting (2)	SAMPLE flashes
Offset	Off, Value 0	OFFSET off	Off, retains value	OFFSET off
Scaling	Off, Value 1	SCALE off	Off, retains value	SCALE off
External Reference	Off, Note 3	EXT REF off	Off, retains last value	EXT REF off
Limits	Off, Value 0	Normal Display	Off, retains last value	Normal Display
Peak	Off	PEAK off	Off, retains last values	PEAK off
Averaging	Off	AVG/(CAL) not on steady	Off (2)	AVG/(CAL) not on steady
Zero	On, Cal Memory Values	ZERO on	Retains mode values and state (4)	ZERO on (VDC,OHMS) or off
Calibration Mode	Note 4		Note 4	

Notes:

1. Re-selection of the same function sets autoranging (AUTO on), but retains all other mode values and states.
2. Disabling Average mode (by changing to a new function) sets filter mode F0 and sample setting 7. If the same function is re-selected, the state of Average mode is not changed, and the existing filter mode and sample setting are retained.
3. The External Reference value is initialized to the multimeter software number whenever power-up or reset occurs. RECALL EXT REF can then be used to display this number. Any subsequent activation of External Reference mode replaces the software number with the actual external reference value.
4. The Calibration mode state is on or off solely dependent on the position of the rear panel Calibration Switch. Do not cycle power on or off with this switch ON.

Calibration mode entries are applied to the reading as follows:

a. Gain correction factors are always applied (Calibration mode on or off).

b. Zero values are applied whenever Zero mode is on (Calibration mode on or off, VDC or OHMS selected). However, the zero values used depend on the Calibration mode state. If Calibration mode is on, the values used are those stored in Calibration Memory. If Calibration mode is off, the Calibration Memory values are loaded into a temporary memory at power-up or reset. Temporary memory values are retained at function selection and can be changed (when Calibration mode is off) without affecting the values stored in Calibration Memory.

the V DC and V AC push buttons are pressed simultaneously and the RMS AC Converter module is installed.

2-28. Status annunciators light to signify various modes of operation. Annunciators (as defined in parentheses) light when any of the following modes are enabled: Peak (PEAK), Scaling (SCALE), or External Reference (EXT), Averaging (AVG/CAL), Offset (OFFSET), Autoranging (AUTO), or V DC/Ohms Zero (ZERO). The FILTER annunciator lights (steadily) whenever the slow filter is selected. The SAMPLE annunciator flashes at the reading (display update) rate for sample settings from 0 through 7. The flash rate for setting 0, 1, or 2 is very rapid: SAMPLE appears steadily on. For sample settings from 8 through 17, the SAMPLE annunciator flashes at the sample setting 7 rate only. Since these higher sample settings may require considerable time for a display update, this feature is necessary to insure that the operator is aware of a reading in progress. With a distinctive display of HI, LO, or PASS, the Limits mode requires no separate status annunciator.

2-29. OVERRANGE INDICATION

2-30. The measurement display presents a distinct indication when overrange inputs are detected. An input voltage exceeding the full scale value for the range selected causes HHHHHH to flash. Overrange points for each range are defined in Table 2-3.

2-31. WARNING INDICATION

2-32. When in the Scaling, External Reference, Offset or Limits mode, there may be no readily discernible display of the true measurement value. Therefore, a single H is flashed in the exponent display when the voltage is 30V or higher at either the front panel input connections or the rear panel external reference terminals.

NOTE

Flashing indicators in the digit or exponent display are a warning only; they have no effect on instrument operation.

2-33. ERROR CODES

2-34. Error codes offer considerable help in identifying improper procedures or equipment configurations. These codes are explained in Table 2-4.

2-35. INTERACTIVE PROGRAMMING INFORMATION

2-36. The multimeter displays prompting messages during STORE and RECALL operations. Whenever the STORE button is pushed, the display responds with "?". The operator may now designate either the displayed value or keystroked numerics as the programming entry. If the displayed reading is being stored, pushing the appropriate terminator button (FILTER, SAMPLE, SCALING, HI OR LO - for LIMITS or OFFSET)

Table 2-3. Measurement Ranges

FUNCTION	DECIMAL POINT POSITION FOR RANGE INDICATED				EXP	OVERRANGE	UNDERRANGE	DIGITS
	1	10	100	1k				
V DC			100 mV		-3	200 mV	—	6½
	1V					2V	.17V	6½
		10V				20V	1.7V	6½
			100V			128V	12V	6½
				1000V		1200V	120V	6½
V AC	1V					2.5V	—	5½
		10V				20V	1.875V	5½
			100V			160V	15V	5½
				1000V		1000V	120V	5½
A AC			100 μA		-6	312.5 μA	—	5½
	1 mA				-3	2.5 mA	234 μA	5½
		10 mA			-3	20 mA	1.875 mA	5½
			100 mA		-3	160 mA	15 mA	5½
	1A					1.28 mA	120 mA	5½
A DC		100 μA			-6	250 μA	—	5½
	1 mA				-3	2 mA	187 μA	5½
		10 mA			-3	16 mA	1.5 mA	5½
			100 mA		-3	128 mA	12 mA	5½
	1A					1.28A	124 mA	5½
OHMS		10				20Ω	—	5½
			100			200Ω	18Ω	5½
	1K				+3	2 kΩ	180Ω	6½
		10K			+3	25 kΩ	1.8 kΩ	6½
			100k		+3	250 kΩ	18 kΩ	6½
	1M				+6	4.1 MΩ	180 kΩ	5½
		10M			+6	35 MΩ	1.8 MΩ	5½
			100M		+6	265 MΩ	18 MΩ	5½

Table 2-4. Error Codes

MOMENTARY ERROR CONDITIONS

(The reading in progress is aborted, but multimeter operation is automatically restored with the next trigger. The function annunciator remains on during a momentary error condition.)

CODE	FAULT	SOLUTION
Error 0	V DC/Ohm Zero, zero attempted in wrong function (not V DC or OHMS) or an overrange has been entered.	Check function. Only V DC and OHMS are permissible.
Error 1	Store attempted during overload condition.	Change to higher range or (if storing cal correction factors) use lower value source.
Error 6	Display overflow error.	Check offset and scaling values.
Error 7	External Reference error - voltage on one input exceeds 20V dc.	Revise external reference input.
Error 8	Controller module is faulty.	Power off; replace controller module.
Error b	Illegal push button sequence in Calibration mode.	Wait till display clears. Use correct sequence.
Error C	Invalid push-button sequence, or illegal value entered.	Wait till display clears. Use correct sequence or value within limits.
Error d	Calibration Memory faulty or not installed. Occurs when storing into, or recalling from, Calibration Memory, or at power-up.	Replace or install Calibration Memory chip.
Error F	Cal Memory check-sum problem.	Try new power-up. If necessary, reprogram Cal Memory. Replacement of Calibration Memory may be required.
Error H	Ohms connection problem.	Verify that all connections are proper. Check input fuses. Check input lead polarity in four-terminal connections.

LATCHING ERROR CONDITIONS

(A valid function must be selected to restore multimeter operation. All function annunciators are off during a latching error condition.)

CODE	FAULT	SOLUTION
Error	System error, usually appears at power-up or reset.	Repeat power-up or reset.
Error 2	Filter module faulty or not installed.	Power off; replace or install filter module.
Error 3	DC Signal Conditioner module faulty or not installed.	Power off; replace or install DC Signal Conditioner module.
Error 4	OHMS, A DC, or A AC error.	Check for improper input level. Check function causing error indication. Applicable module may need replacement or installation.
Error 5	Analog to Digital Converter Module error.	Power off; replace or install Analog to Digital Converter module.
Error 9	Function selection error. The function module selected is faulty or not installed. V DC problem causes Error 3.	Select valid function to clear error condition. Power off; replace or install appropriate module.
Error E	More than one ac converter, or the wrong ac converter, is installed. Also appears when Calibration Memory module is installed.	Power off, remove one ac converter, or install correct converter, or remove the Calibration Memory module (the multimeter uses a separate Calibration Memory as part of the Controller).

completes the operation. The multimeter adopts both the mode specified with the terminator and the value previously displayed. If keystroked numerics are being stored, the multimeter displays the digits as they are entered from the front panel. Once all numbers for a particular mode are entered, the appropriate terminator button is pushed. For either method, the display now resumes the measurement reading function or, if HI or LO were specified as the terminator, begins reading HI, LO, or PASS.

2-37. The RECALL button commands a display of a stored factor or value. The procedure requires the following two steps when recalling the offset value, the scaling factor, the filter mode, the sample setting, or the zero value:

1. Push the RECALL button (display responds with "?").
2. Push the appropriate terminator button (OFFSET, SCALING, FILTER, SAMPLE or ZERO). The respective value is displayed as long as the terminator button is held depressed. Once the terminator button is released, the multimeter resumes operation; no mode or value is changed.

2-38. The following three push button steps are required to recall a limit or peak value.

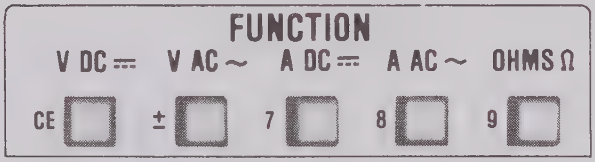
1. Push RECALL (display responds with "?").
2. Then specify whether upper or lower limit or peak is desired by pushing HI or LO (display responds with "YES?").
3. Finally, push the appropriate terminator button (LIMITS or PEAK).

2-39. Front Panel Push Buttons

2-40. The multimeter employs 25 color-coded push buttons on the front panel. Most of the push buttons control more than one function. For example, many mode control push buttons also serve as numeric entry push buttons when used during a store operation. The number of keystrokes required for any operation is kept to a minimum. Refer to Figure 2-2 for a description of each push button and, where applicable, examples of typical programming operations.

2-41. Operation of the multimeter is straightforward. Preset measurement configurations are made at power-up, reset, or function selection. Programmed values are retained whenever the range or function is changed. Desired mode changes are made independently following a programming hierarchy of:

1. Measurement Parameters
2. Mathematic Operations
3. Special Operations



The FUNCTION push buttons allow selection of the analog measurement function. Available functions include: dc volts (V DC), ac volts (V AC), dc current (A DC), ac current (A AC), and resistance (OHMS — two wire or four wire).

V DC ☐ Push V DC for dc voltage measurements with 6½-digit resolution (V DC annunciator lights). This function is standard for the multimeter (no optional module required). Five ranges are available: 1000V, 100V, 10V, 1V, and 100 mV.

V AC ☐ Push V AC for ac voltage measurements with 5½-digit resolution (V AC annunciator lights). This function can be used with either the -01 Averaging Converter or the -09A RMS Converter. Four ranges are available: 1000V, 100V, 10V, and 1V.

A DC ☐ Push A DC for dc current measurements with 5½-digit resolution (A DC annunciator lights). This function can be used with the -03 Current Shunts module installed. Five ranges are available: 1A, 100 mA, 10 mA, 1 mA, and 100 μA.

A AC ☐ Push A AC for ac current measurements with 5½-digit resolution (A AC annunciator lights). This function can be used when the -03 Current Shunts module and either the -01 Averaging Converter or the -09A RMS Converter is installed. Available ranges are identical to those in the A DC function.

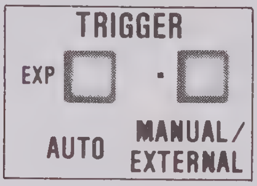
Figure 2-2. Front Panel Push Buttons

OHMS
☐

Select the OHMS function to make resistance measurements (OHMS annunciator lights). The -02A Ohms Converter must be installed. Eight resistance ranges are available: 100 MΩ, 10 MΩ, 1 MΩ, 100kΩ, 10 kΩ, 1 kΩ, 100Ω and 10Ω.

NOTE

Either two-wire or four-wire resistance measurements can be made. Refer to Measurement Terminals and Controls.

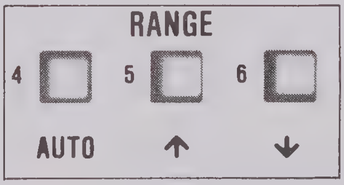


☐
AUTO

The AUTO (trigger) push button selects the Auto Trigger mode. A flashing SAMPLE annunciator verifies Auto Trigger operation.

☐
MANUAL/ EXTERNAL

Initial use of the MANUAL/EXTERNAL push button disables the Auto Trigger mode (SAMPLE annunciator stops flashing), enables the front panel Manual Triggering mode, and arms the External Triggering mode. Each succeeding use of the MANUAL/EXTERNAL push button triggers a new measurement: any reading already in progress is aborted and the new reading begun immediately. The SAMPLE annunciator verifies that a measurement has been triggered by flashing once, or several times (if the sample-per-reading setting is greater than 7, 2 exponent 7 = 128 samples). An external trigger applied through the rear panel external trigger jack similarly commands a new reading. An external trigger applied simultaneously with a front panel manual trigger will be ignored. AUTO must be pushed to reenter the Auto Triggering mode.



☐
AUTO

AUTO RANGE toggles into/out of the Autoranging mode, changing the existing range if necessary. When enabled (AUTO annunciator lighted), Autoranging automatically selects a range that displays the measurement with maximum resolution.

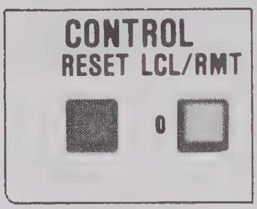
☐
↑

Each use of this manual ranging push button selects the next higher available range. if AUTO RANGE was previously activated, use of the uprange push button toggles out of Autoranging (AUTO annunciator off) and steps to the next higher range. No range change is effected if the multimeter is already in the highest range.

☐
↓

Use of the down-range push button causes the multimeter to toggle out of Autoranging (AUTO annunciator off) and assume the next lower available range. Each successive use of the down-range button selects the next lower range. This push button has no effect once the multimeter is in the lowest available range.

Figure 2-2. Front Panel Push Buttons (cont)



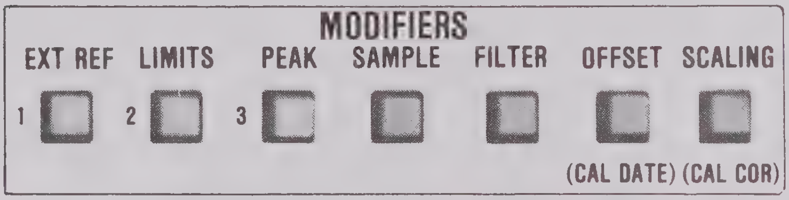
RESET
☐

CAREFUL: The RESET push button is powerful: all modes and stored values (other than calibration factors) are lost if RESET is pressed. Once RESET is used, the multimeter assumes the Power-Up configuration (without actual power loss). Temporary zero values are replaced with zero values stored in Calibration Memory.

LCL/RMT
☐

Depending on the remote interface being used, pushing the LCL/RMT button may cause one of three multimeter responses.

1.) If the -05 IEEE Interface is installed, LCL/RMT may be used to command local (front panel) control only if the multimeter is already in remote (REMOTE annunciator lighted). The push button has no effect if the multimeter is already in local.
2.) If the -06 Bit Serial Interface or the -07 Parallel Interface is installed, LCL/RMT may be used to toggle into/out of local control at any time.
3.) If no remote interface is installed, use of LCL/RMT causes a latching error condition.



EXT REF
☐

The EXT REF button toggles into/out of the External Reference mode. Either External Reference or Scaling may be enabled: selection of one mode disables the other. After power-up or reset, RECALL EXT REF can be used to identify the software version.

NOTE

The external reference voltage, applied through the rear input connector, can be read in the display while EXT REF is held depressed.

LIMITS
☐

The LIMITS push button toggles into/out of the Limits mode without changing stored limits values. A display of HI, LO, or PASS denotes use of the Limits mode.

PEAK
☐

The PEAK push button toggles into/out of the Peak mode. While in the Peak mode (PEAK annunciator lighted), a continually updated record of the highest and lowest reading values is stored. These values are also held in memory after the mode is disabled. Reentry into the PEAK mode erases previously recorded values and begins a new recording.

SAMPLE
☐

Different reading rates can be specified by selecting the number of samples averaged per measurement. There are two methods for making this selection.

1.) The SAMPLE button can be pushed to toggle between two commonly used reading rates: slow (1.9 readings-per-second, SAMPLE annunciator flashes slowly) and fast (7.5 readings-per-second, SAMPLE annunciator flashes rapidly).

Figure 2-2. Front Panel Push Buttons (cont)

2.) Any of 18 different reading rates can be specified using the following push button sequence:

STORE (0-17) SAMPLE

The SAMPLE annunciator now flashes at a specified rate. For settings of 0-7, this rate is the reading rate. For the slower settings of 8-17, a single rate is preset to indicate a reading in progress.

FILTER

☐

Two methods are available for filter selection.

1.) By toggling the FILTER push button, the operator can select mode F (no mode number) or F0 (mode number 0).

2.) The following sequence can be used to select any of the five filter modes:

STORE (mode number) FILTER

MODE NUMBER	FILTER	TIMEOUT	FILTER LED
(blank)	slow	none	on
0	fast	none	off
1	bypass	none	off
2	slow	550 ms	on
3	fast	50 ms	off
(No Mode Number is used for slow filter without timeout. Push STORE FILTER.)			

OFFSET

☐

The OFFSET push button can be used to toggle into/out of the Offset mode (OFFSET annunciator lights). Two methods are available for simultaneously entering an offset value and activating the Offset mode.

1.) A numeric value may be entered using a store sequence. For example, store an offset of 1.25 as follows:

STORE 1 . 2 5 OFFSET

2.) A displayed reading can be stored as the offset value. Use the following sequence:

STORE OFFSET

NOTE

In some instances, the displayed value may not be an appropriate offset value. For example, if the displayed value is being used to zero the multimeter, it is important to verify that no other mathematic operations are in effect. In such a case, check that OFFSET, SCALING, and EXT REF annunciators are all off before storing a new offset value.

Figure 2-2. Front Panel Push Buttons (cont)

(CAL DATE)
☐

When the multimeter is in the Calibration Mode (AVG/(CAL) annunciator flashes), the (CAL DATE) push button is used to enter six digits which either denote the date or identify the multimeter by number. Refer to Calibration Mode later in this section.

SCALING
☐

The SCALING push button can be used to toggle into/out of the Scaling mode without affecting any scaling value already stored. Either of the following two methods can be used to store a new scaling factor and enable the Scaling mode:

NOTE

Verify that the displayed value is the desired scaling value. Any mathematic operations (SCALING, EXT REF, OFFSET) already in effect must be cancelled if the actual measurement is desired as the scaling value. To cancel any of these modes, toggle SCALING, EXT REF, or OFFSET and verify that the respective annunciators are dark.

1. Use the following sequence to store the display as a scaling factor:

   STORE SCALING

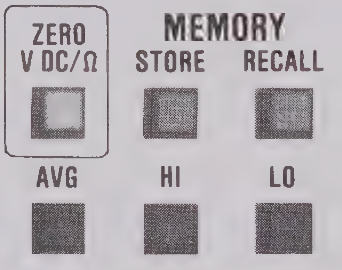
2. Numeric entry scaling factors must be programmed using the following procedure:

   STORE (numerics) SCALING

With either method, the Scaling mode is entered with the initial use of the SCALING button.

(CAL COR)
☐

The (CAL COR) push button is used when storing calibration factors for each function and range, or when recalling uncorrected readings. Refer to Calibration Mode later in this section.



STORE
☐

STORE is used as a first step in programming certain measurement parameters, mathematic operations, or special operations. STORE is the only push button that can activate the numeric entry keys. The multimeter prompts the second step by displaying "?". Following is a list of STORE operations:

Measurement Parameters:

STORE	0-17	SAMPLE
	0,1,2,3 or blank	FILTER

Figure 2-2. Front Panel Push Buttons (cont)

Mathematic Operations:

To store the displayed value as an offset or scaling value and enter the respective mode:

$$\text{STORE} \qquad \left\{ \begin{array}{l} \text{OFFSET} \\ \text{SCALING} \end{array} \right.$$

To store a numeric entry as an offset or scaling value and enter the respective mode:

$$\text{STORE} \qquad \text{(numerics)} \qquad \left\{ \begin{array}{l} \text{OFFSET} \\ \text{SCALING} \end{array} \right.$$

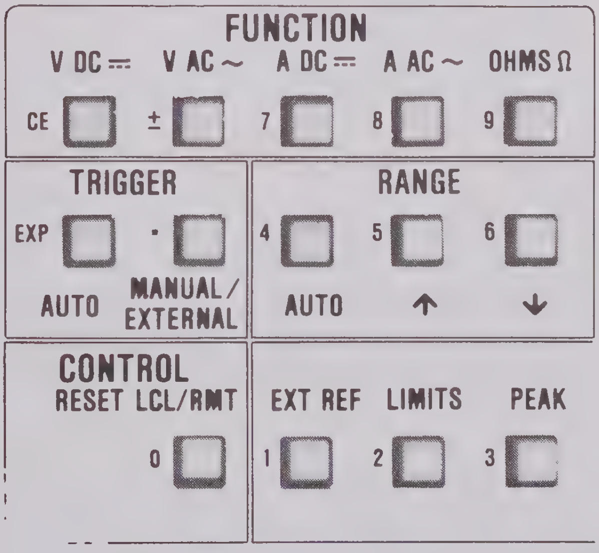
Special Operations:

To store the displayed value as a high or low limit and enter the Limits mode:

$$\text{STORE} \qquad \left\{ \begin{array}{l} \text{HI} \\ \text{LO} \end{array} \right.$$

To store a numeric entry as a high or low limit and enter the Limits mode:

$$\text{STORE} \qquad \text{(numerics)} \qquad \left\{ \begin{array}{l} \text{HI} \\ \text{LO} \end{array} \right.$$



The multimeter utilizes fourteen dual purpose push buttons as numeric entry keys. When programming sample settings or filter modes, a one- or two-digit entry is necessary. When programming limits, or scaling and offset values, a longer entry may be required. Therefore, the following sequence is available:

Mantissa Field:	enter a maximum of seven digits, with decimal point. Toggle polarity (±) button as required.
Exponent Field:	push EXP button, then enter a single digit exponent. Toggle the polarity button again to set the exponent polarity.

Use the CE push button at any time prior to the terminator (last button in a store numeric sequence) to clear all numerics and revert to a "?" display. Fresh numerics may then be entered immediately.

Figure 2-2. Front Panel Push Buttons (cont)

RECALL

☐

The RECALL push button can be pressed to recall and display values stored in the Limits, Peak, Scaling, Offset, Zero, External Reference, Sample or Filter modes. For recall of uncorrected readings, dates and identifiers, refer to Calibration Mode later in this section. No stored value is affected during the RECALL operation. The recalled value will be displayed as long as the last push button in the sequence is held depressed.

To recall measurement parameters:

$$\text{RECALL} \quad \left\{ \begin{array}{c} \text{SAMPLE} \\ \text{FILTER} \end{array} \right.$$

To recall mathematic operation values:

$$\text{RECALL} \quad \left\{ \begin{array}{c} \text{OFFSET} \\ \text{SCALING} \\ \text{EXT REF} \\ \text{ZERO V DC}/\Omega \end{array} \right.$$

To recall a special operation value:

$$\text{RECALL} \quad \left\{ \begin{array}{c} \text{HI} \\ \text{LO} \end{array} \right. \quad \left\{ \begin{array}{c} \text{LIMITS} \\ \text{PEAK} \end{array} \right.$$

ZERO
V DC/Ω

☐

The ZERO push button can be used to store a dc volts zero (any range) or ohms zero (any range). The zero value stored is also applied on all higher ranges in the same function. For discrete zero values on each range, zero must be stored sequentially on each range (from lowest to highest). With the initial button push, a new zero value is stored and the mode is enabled (ZERO annunciator on). Pushing ZERO a second time disables the mode, but retains the previous value. A new zero value is stored each time Zero mode is enabled. Refer to text for use with Calibration mode.

AVG

☐

The AVG push button can be used to optimize sample and filter factors for each function and range combination. A stable reading is thereby assured. An additional digit (using the exponent display) is available in 10V dc range when in the Averaging mode.

HI

☐

LO

☐

The HI and LO push buttons are used to store or recall limit values and for recall only of peak values. Refer to STORE and RECALL push button descriptions for the applicable sequence.

Figure 2-2. Front Panel Push Buttons (cont)

2-42. Measurement parameters (range, sample, filter, trigger, averaging, zero) define all operations that affect the resolution, stability, and accuracy of the reading. For example, the range is specified to position the decimal point, and the filter mode may be changed to improve noise rejection.

2-43. Mathematic operations (External Reference or Scaling, Offset) alter the reading to operator requirements. For example, when Offset is used, only the difference between the reading and the offset value is displayed.

2-44. Special operations (limits, peak) specify how the reading is used. For example, Peak mode can be used to continuously update a record of the highest and lowest readings, or Limits mode may be used for a HI, LO, PASS display of the measurement reading. A comprehensive setup routine is summarized in Figure 2-3. All or part of this routine can be used to establish or change measurement parameters, mathematic operations, or special operations.

2-45. Error codes usually identify any programming problem and specify a solution (refer to Table 2-4). A numeric entry may be aborted at any time prior to termination by pushing the CE button. The multimeter responds by displaying "?": another numeric entry may now be made, or the displayed value may be stored by pushing the desired terminator button. A store or recall operation can be entirely aborted prior to execution by pressing STORE or RECALL a second time. The multimeter reverts to its state prior to the store or recall once a momentary Error C condition elapses.

NOTE

Errors due to thermal emf's should be considered when making low level, high resolution measurements. Thermal emf's (voltages produced by temperature differences between contacts of two dissimilar metals or by temperature gradients along a length of material) may cause differences of several microvolts. The use of low emf, shielded cables with copper spade lugs is recommended to minimize thermal emf errors.

If multiple programming steps are required, use the sequence presented here as a general guide. Use the push button(s) shown for the action described.

INITIALIZATION

CONFIGURATION AT POWER-UP OR RESET (V DC, 1000V, Auto, Sample 7, Filter F0, zero mode ON, no other modes or values). Calibration mode must be off before power-off.

STEP	ACTION	PUSH BUTTONS	
1	FUNCTION selection		
	a. Reselecting V DC sets autoranging.	V AC ☐	A DC ☐
	b. Push V AC and V DC simultaneously to measure ac voltage on a dc level (with RMS converter option -09A).	A AC ☐	OHMS ☐

CONFIGURATION AT FUNCTION CHANGE
(Autorange; previous filter, sample and trigger retained; all other modes off but respective values retained.)

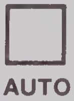
Figure 2-3. Programming Hierarchy

MEASUREMENT PARAMETERS

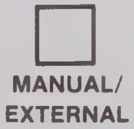
Measurement parameters establish reading resolution, noise rejection, stability and accuracy.

2 TRIGGER selection

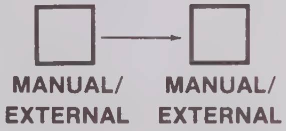
a. If in manual, change to auto



b. If in AUTO, change to manual

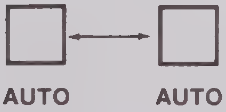

MANUAL/
EXTERNAL

c. Manual triggers

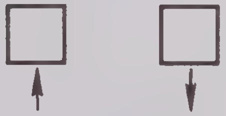

MANUAL/
EXTERNAL
MANUAL/
EXTERNAL

3 RANGE selection

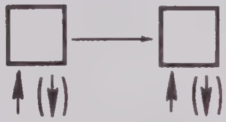
a. Toggle into/out of autoranging



b. Select manual ranging, step to next higher, lower range.

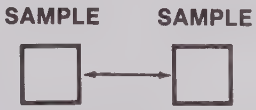


c. Continue stepping to available higher, (lower) ranges.



4 Reading Rate Selection

a. Toggle between sample settings 5 (2 exp 5 = 32) and 7 (2 exp 7 = 128)


SAMPLE
SAMPLE

b. Select any sample setting from 0 (2 exp 0 = 1) to 17 (2 exp 17 = 131,072)

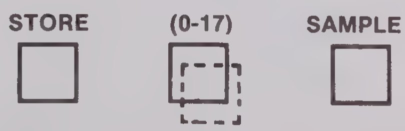
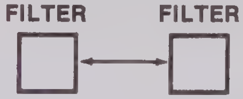

STORE
(0-17)
SAMPLE

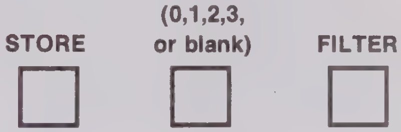
Figure 2-3. Programming Hierarchy (cont)

5 FILTER selection

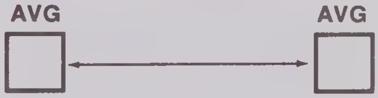
a. Toggle between filter F (slow) and F0 (fast)


FILTER
FILTER

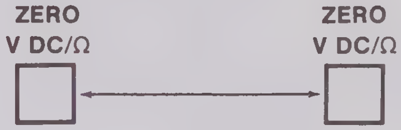
b. Select filter F, F0, F1, F2, or F3.


STORE
(0,1,2,3, or blank)
FILTER

6 Averaging: toggle on/off (presets filter, sample)



7 V DC/OHMS Zero: toggle on/off (V DC or OHMS only). New zero stored each time mode is enabled. Refer to text for use with Calibration mode.


ZERO V DC/Ω
ZERO V DC/Ω

MATHEMATIC OPERATIONS

Stop here if only a direct measurement reading is desired. Further steps yield ratio, deviation, percentage variation and other special readings.

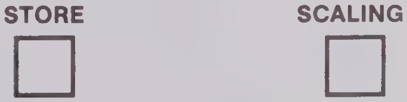
Refer to Applications in this Section for examples.

NOTE

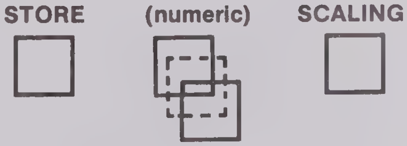
Scaling (or External Reference) is applied first. The result of this operation is then offset.

8 SCALING selection (disables External Reference)

a. Store displayed value, enter Scaling mode


STORE
SCALING

b. Store numeric value (non-zero), enter Scaling mode.


STORE
(numeric)
SCALING

c. Toggle into/out of Scaling mode while retaining value.

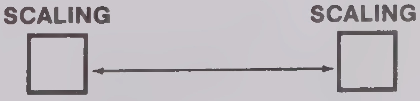
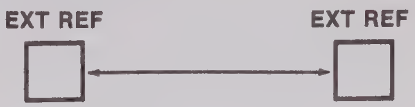

SCALING
SCALING

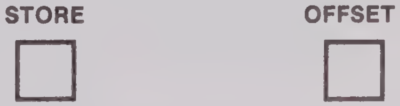
Figure 2-3. Programming Hierarchy (cont)

9 EXTERNAL REFERENCE selection (disables Scaling) — toggle on/off.

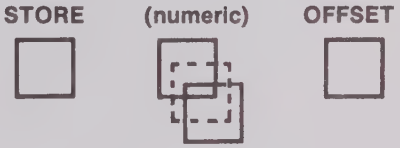

EXT REF
EXT REF

10 OFFSET selection

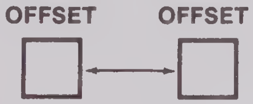
a. Store displayed value, enter Offset mode


STORE
OFFSET

b. Store numeric value, enter Offset mode


STORE
(numeric)
OFFSET

c. Toggle into/out of Offset mode while retaining value.

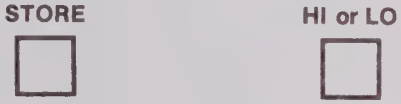

OFFSET
OFFSET

SPECIAL OPERATIONS

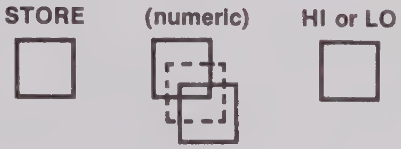
Use the reading, as modified by any math operations, for comparison with set limits, or record the reading maximum deviations.

11 LIMITS selection

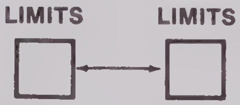
a. Store displayed value, enter Limits mode


STORE
HI or LO

b. Store numeric values, enter Limits mode


STORE
(numeric)
HI or LO

c. Toggle into/out of Limits mode while retaining values.


LIMITS
LIMITS

12 PEAK: toggle into/out of Peak mode. Previous peak values are lost each time the mode is reentered.

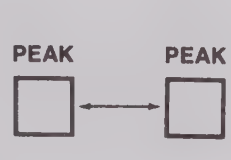


Figure 2-3. Programming Hierarchy (cont)

2-46. Measurement Terminals and Controls

2-47. GUARDING

2-48. General

2-49. Guarding may be used to reduce noise and improve accuracy. Common mode voltages, resulting from currents and voltage drops between two points otherwise electrically common, may cause significant errors. Proper use of a floating, guarded multimeter minimizes these errors.

2-50. Generally, guarding should be employed where long signal leads are used, when signal source impedance is high, when making measurements near high-level radiated noise (particularly at the power line frequency), or when making floating measurements.

NOTE

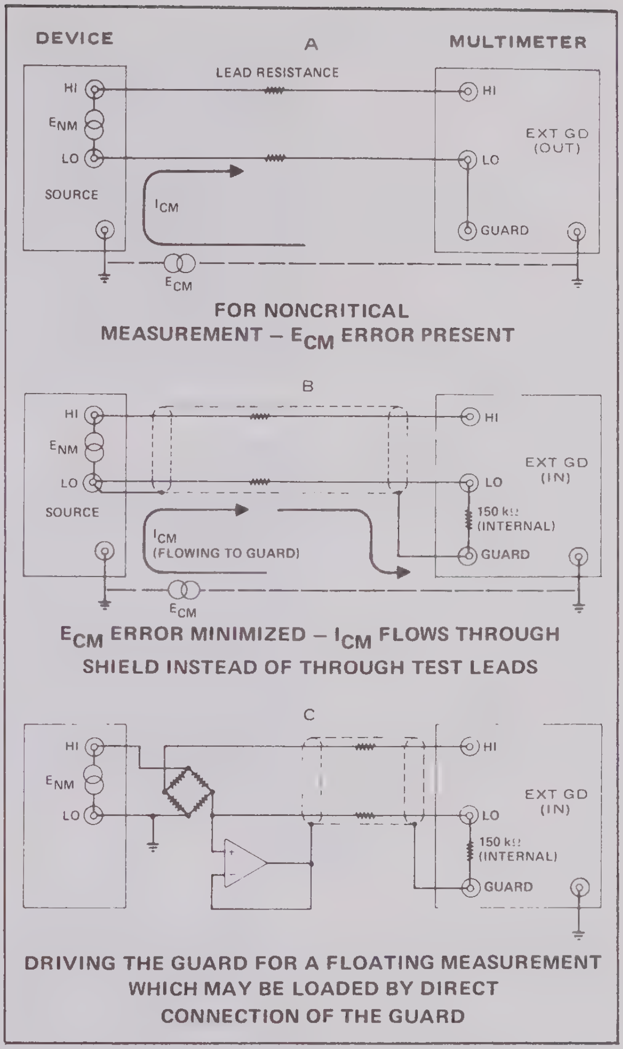
Errors due to thermal emf's should be considered when making low level, high resolution measurements. Thermal emf's (voltages produced by temperature differences between contacts of two dissimilar metals or by temperature gradients along a length of material) may cause differences of several microvolts. The use of low emf, shielded cables with copper spade lugs is recommended to minimize thermal emf errors.

2-51. Guard Selector

2-52. Correct use of the multimeter GUARD terminal both protects the instrument and provides more accurate readings. The EXT GD IN selector, when disengaged (out), enables the internal guard connection. In many cases accurate measurements may be made with the selector in this position (shown as A in Figure 2-4). Here, the difference in potential between multimeter ground and device ground is very small, or the measurement is not critical. When pushed in, the selector disables the internal guard connection and allows for external guard connections as shown in B and C of Figure 2-4. The connection shown in B is better than that in A, since some common mode current (ICM) is shunted away from the source resistance. The connection shown in C is necessary when the source may not be capable of driving the guard. The buffer amplifier shown in C prevents this source loading. Practical considerations usually dictate which of the three connections is used.

2-53. Guard Terminal

2-54. Recommended guard terminal connections are illustrated in Figure 2-4. The potential between GUARD and chassis ground must not exceed 500V. The potential between SENSE LO and GUARD must not exceed 127V.



FOR NONCRITICAL MEASUREMENT – E_{CM} ERROR PRESENT

E_{CM} ERROR MINIMIZED – I_{CM} FLOWS THROUGH SHIELD INSTEAD OF THROUGH TEST LEADS

DRIVING THE GUARD FOR A FLOATING MEASUREMENT WHICH MAY BE LOADED BY DIRECT CONNECTION OF THE GUARD

Figure 2-4. Guard Connections

2-55. VOLTS INPUT/OHMS SENSE (HI and LO) TERMINALS

2-56. The VOLTS INPUT/OHMS SENSE terminals are used when making voltage (dc and/or ac) and resistance measurements. Connections are shown in Figure 2-5. The input on the HI terminal with respect to the LO terminal must not exceed 1000V. The LO to GUARD potential must not exceed 127V. These terminals are internally shorted to the AMPS INPUT/OHMS SOURCE terminals (HI to HI, LO to LO) when the Ohms Selector (4T OHMS IN) is in the disengaged (2-wire) position.

NOTE

In OHMS measurements, the voltage at the SENSE INPUT terminals is sampled before the Ohms Converter (Option 02) is connected. No connection is made if excessive voltage (±10V dc) is present.

2-57. AMPS INPUT/OHMS SOURCE (HI and LO) TERMINALS

2-58. The AMPS INPUT/OHMS SOURCE terminals are used when making current (A DC or A AC) or four-wire resistance (OHMS) measurements. The potential between SOURCE HI and SOURCE LO must not exceed 280V. The potential between SOURCE HI and SENSE HI, or between SOURCE LO and SENSE LO must not exceed 127V.

NOTE

In current measurements, the voltage at the input terminals is sampled before the Current Shunts module (Option 03) is connected. No connection is made if excessive voltage (±45 V dc) is present.

2-59. OHMS SELECTOR

2-60. When engaged (in), the Ohms Selector isolates SENSE HI from SOURCE HI and SENSE LO from SOURCE LO; four-wire resistance measurements can then be made. When disengaged (out), SENSE HI is connected to SOURCE HI and SENSE LO is connected to SOURCE LO for two-wire resistance measurements. Refer to Figure 2-5. Note that this control should be in the disengaged (out) position only when two-wire resistance measurements are being made. The Ohms Selector has no control of the rear inputs (a four-wire configuration is preset).

2-61. REAR INPUT SELECTOR

2-62. When pushed in, the Rear Input Selector disconnects the front panel inputs and connects the rear input connector. The Ohms Selector and Guard Selector have no effect when rear inputs are enabled. The state of the Rear Input Selector can be sensed remotely through any of the remote interface options.

2-63. Function

2-64. Selection of a new function automatically cancels any previously selected function and places the multimeter in the function change configuration. If the same function is successively selected, the multimeter assumes the Autoranging mode, but retains all other modes and values existing prior to the reselection. A valid new function selection is verified when the appropriate display annunciator(s) lights (V DC, V AC, A DC, A AC, OHMS, or V DC + V AC). An invalid function selection occurs whenever the necessary analog measurement module is not installed or is faulty; either ERROR 9 or ERROR 3 appears in the display in such cases. Once an invalid function has been selected, the multimeter ignores all other push buttons until a valid function is selected.

2-65. Measurement Parameters

2-66. SAMPLING

2-67. The multimeter averages a number of samples for each reading (display update). Noise rejection is influenced by the number of samples-per-reading and by the filter selection. Each sample-per-reading setting yields a specific processing time. Additional processing time is necessary when mathematic operations (such as OFFSET or SCALING) are involved. Samples taken are synchronous to the line frequency for local operation. Synchronous or asynchronous operation can be specified remotely.

2-68. Sample settings are specified as exponents of two. For example, the SAMPLE push button can be used individually to toggle between settings 5 (2 exponent 5 = 32 samples-per-reading) and 7 (2 exponent 7 = 128 samples-per-reading). Further, any sample setting (exponent of 2) from 0 through 17 may be made using the STORE (numeric) SAMPLE sequence. If a setting of 0 through 6 is in effect when SAMPLE is toggled, the multimeter assumes setting 7. A previous setting of 7 through 17 is changed to 5 when SAMPLE is toggled.

2-69. The SAMPLE annunciator is controlled by both the sample setting and the trigger. At sample settings from 0 through 7, SAMPLE flashes once for each triggered reading. The rapid reading rate at 0 or 1 setting yields an apparent steady indication. At sample settings 8 through 17, the flash rate is preset to that of setting 7. This feature insures a reliable reading-in-progress indication at these slower reading rates.

2-70. TRIGGERING

2-71. Each new measurement is initiated with a trigger. In auto triggering, each trigger is generated internally at the end of the required reading time. Triggers may also be applied locally (from the front panel) or remotely.

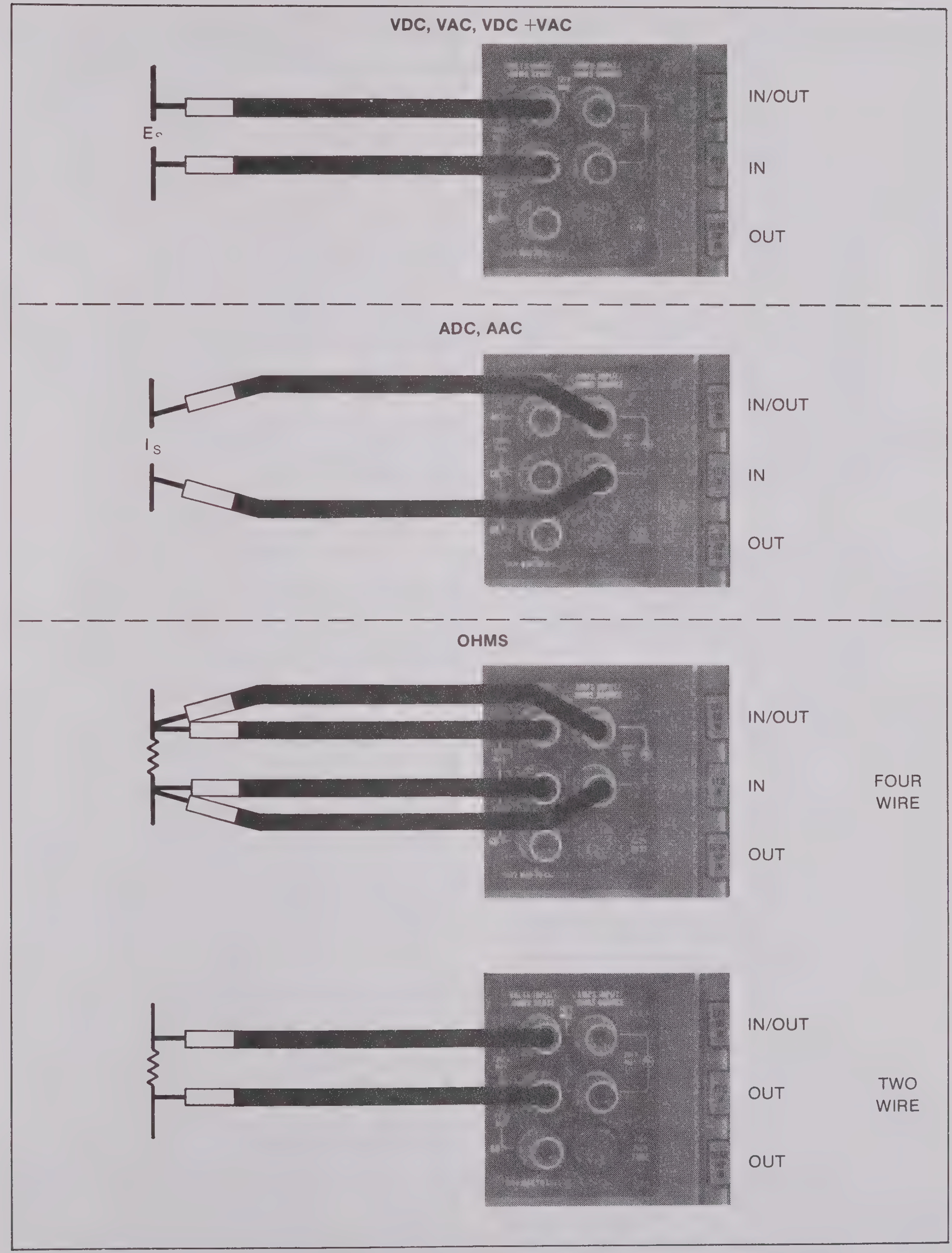
2-72. Auto trigger commands a continuously updated reading. The frequency of this updating is influenced by the number of samples-per-reading and by any extra processing time required by mathematic operations. The SAMPLE annunciator flashes to indicate the triggering of a new reading.

2-73. Local triggers can be manually commanded from the front panel. The duration of each reading is determined in the same manner as the auto triggers (samples, mathematics). Each use of the MANUAL/EXTERNAL push button commands an immediate response from the multimeter; any reading already in progress is aborted and a new reading begun. During any manually triggered reading, use of any other push button halts the multimeter; a new trigger must then be entered. Conversely, between manually triggered readings, the multimeter is inhibited; no display update or SAMPLE annunciation is evident. During this interval, any measurement parameter, mathematic operation, or special operation may be entered, but is not initiated until the next manual trigger is entered.

2-74. External triggers are applied through the rear panel TRIGGER jack. A local trigger manually applied from the front panel overrides a simultaneously applied external trigger.

2-75. FILTERING

2-76. Two analog filters are available: either one of these, or filter bypass, may be selected. The slow filter provides better normal mode rejection. The fast filter allows for faster instrument settling while still providing a degree of noise rejection. Whenever a filter is used, a



VDC, VAC, VDC +VAC

ADC, AAC

OHMS

E_S
IN/OUT
IN
OUT
I_S
IN/OUT
IN
OUT
IN/OUT
IN
OUT
FOUR WIRE
IN/OUT
OUT
OUT
TWO WIRE

Figure 2-5. Measurement Connections

timeout (for settling delay) may also be inserted before each reading. No filtering is available for the external reference input.

2-77. Two methods of filter selection are available. Selection of any mode (F, F0, F1, F2, F3) is possible using the STORE (numeric) FILTER sequence. The FILTER push button by itself toggles between modes F and F0. The slow filter (F) is always selected when a toggle is performed with a fast filter (F0, F1, or F3) in effect. The fast filter (F0) is always selected when a slow filter (F or F2) is in effect. Mode F0 is preselected at power-up or reset.

2-78. AVERAGING

2-79. The Averaging mode presets the sample setting to 10 and the filter mode to F to provide optimum stability and resolution throughout the range of inputs. Subsequent FILTER or SAMPLE selection may jeopardize this intended optimization. Therefore, sample settings less than 10 cause the multimeter to exit the Averaging mode. Filter mode F2 can also be specified while in the Averaging mode. Selection of any filter other than F or F2 is accepted by the multimeter, but causes deactivation of Averaging mode.

2-80. The Averaging mode can be used to improve display stability (reduce rattle) in all ranges and to increase display resolution in certain ranges. Preset resolutions used for standard operation and for the Average mode are summarized in Table 2-5.

2-81. RANGE

2-82. Ranges available in each function are summarized in Table 2-3. A power-up or reset condition sets the multimeter in the 1000V range, Autoranging disabled. Each function selection enables Autoranging (AUTO annunciator on). In Autoranging, the multimeter selects the range offering maximum resolution for the measured value. The AUTO (range) push button toggles Autoranging mode on or off. When toggling off, no range change is effected. Either of the up/down push buttons select manual ranging and step up/down one range when initially used. Each subsequent use steps to the next higher/lower range (if available).

2-83. V DC AND OHMS ZERO

2-84. In VDC or OHMS, internal dc drift may be corrected by zeroing. If Calibration mode is off, the values are stored in a temporary memory and do not affect Calibration Memory entries. The value stored at a zero input level is used as a zero correction for the selected range and for all higher ranges in the same function. Separate zero values for each range can thereby be stored by starting with the lowest range and working up. Calibration Memory values are automatically loaded into the temporary memory when power-up or reset occurs. If Calibration mode is on, the zero values are stored in Calibration Memory. In this case, each zero value stored does not affect values on any other range.

Table 2-5. Resolution

	RANGE	NORMAL DIGITS	AVERAGING DIGITS
V DC	100 mV	6½	6½
	1V	6½	6½
	10V	6½	7½
	100V	6½	6½
	1000V	6½	6½
V AC,	1V	5½	6½
OR	10V	5½	6½
V AC + V DC	100V	5½	6½
	1000V	5½	6½
A DC	100 μA	5½	6½(5½A AC)
or	1 mA	5½	6½
A AC	10 mA	5½	6½
	100 mA	5½	6½
	1A	5½	6½
OHMS	10Ω	5½	6½
	100Ω	5½	6½
	1 kΩ	6½	6½
	10 kΩ	6½	6½
	100 kΩ	6½	6½
	1 MΩ	5½	6½
	10 MΩ	5½	6½
	100 MΩ	5½	6½

2-85. Good quality, low thermal shorting bars (not shorted test leads) must be applied between INPUT HI and LO terminals during the zero operation. Initial use of the ZERO V DC/OHMS push button stores the zero correction value and activates the Zero mode (ZERO annunciator lights). Pressing ZERO V DC/OHMS a second time deactivates the Zero mode (ZERO annunciator goes off). A new zero value is entered each time the mode is enabled. Scaling and offset values are ignored in the stored correction value. Attempting to store zero in an illegal function (A DC, A AC, or V AC) results in an Error 0 indication. Exiting the zeroed function deactivates the Zero mode, but retains the stored values. Upon reentering the zeroed function, Zero mode and the old value are automatically restored. The zero value can be recalled for the selected range and function (VDC or OHMS).

2-86. Mathematic Operations

2-87. Mathematic operations can be specified to change the measured value (as influenced by measurement parameters) before it is actually displayed. Ratio, deviation, percentage variation and other mathematically manipulated displays are thereby possible. Scaling (or External Reference) can be used to divide the measured value and display the ratio. An offset value can be subtracted from the measured value to display only the deviation. Scaling (or External Reference) and Offset can be used in combination to display percentage variation. Examples of such operations are given under Applications later in this section.

2-88. Use of mathematic operations is expressed in the following formula:

$$\text{DISPLAY} = \frac{\text{MEASURED VALUE}}{\begin{array}{c}\text{SCALING}\\ \text{(OR EXTERNAL REFERENCE)}\end{array}} - \text{OFFSET}$$

Measured value in this formula refers to the measurement as influenced by all selected measurement parameters. This value is subject to the following function-dependent considerations.

1. V DC function: measured value is the measured voltage less V DC Zero when the Zero mode is used.
2. OHMS function: measured value is obtained after any applicable OHMS Zero is applied.

2-89. SCALING

2-90. The Scaling mode divides the measured value (after application of V DC or OHMS zero) by a known amount and displays the quotient. Ratios, percentage deviations, or input/output relationships can thereby be displayed. The scaling divisor may be a previously displayed and stored value, or any non-zero numeric entry from $+10^9$ to $+10^{-9}$ and from -10^9 to -10^{-9}. When compared to External Reference, Scaling offers a much wider range. Only one scaling factor may be stored at a time.

2-91. Storing the displayed value as a scaling factor warrants a word of caution: insure that the displayed value is the true original display by first toggling out of Scaling and Offset modes (respective annunciators off). No stored scaling or offset value is lost in this manner. To store the desired display, push STORE SCALING.

NOTE

If the multimeter is in both Scaling and Offset modes, the scaling value is applied before the offset value.

2-92. EXTERNAL REFERENCE

2-93. Scaling and External Reference modes are mutually exclusive: selection of either mode automatically disables the other. The external reference value (always measured as a dc voltage) is applied as an unswitched input through the rear input connector.

2-94. Immediately after a power-up or reset, RECALL EXT REF can be used to verify the software version number. The first subsequent use of EXT REF to activate External Reference mode disables this software identification feature. When toggling into the mode, the reference voltage is displayed as long as the EXT REF button is depressed. The EXT annunciator is lighted when the mode is enabled.

2-95. The applied External Reference voltage may be a maximum of ±20V dc on either high or low input with respect to VOLTS INPUT LO. The voltage between External Reference high and low may not exceed 40V dc. The minimum acceptable External Reference voltage is the greater of ±100 uV or a value found with the following formula:

$$\text{Vmin} = \frac{\pm\ \text{Vin}}{10^9}$$

2-96. Normally, the External Reference low terminal is tied to VOLTS INPUT LO. In any event, the resistance between either External Reference terminal and VOLTS INPUT LO should be less than 20 kilohms. A reading rate of eight samples-per-reading and filter bypass are specified for each External Reference input.

2-97. OFFSET

2-98. In Offset mode, the display represents only the deviation from a stored offset value. Measurements of stability of analog variation are thereby possible. The multimeter automatically subtracts a programmed numeric (or previously stored display value) from the measurement and displays the result. No increase in resolution is displayed while in the Offset mode. One value (whether a numeric or a previous display) may be stored at a time. Programmed numerics may range from $+10^9$ to -10^9 (excluding 0). The stored offset value may be recalled at any time.

2-99. Special Operations

2-100. PEAK

2-101. The highest and lowest deviations in the displayed value may be recorded in the Peak mode. Measurement stability may thereby be checked over a period of time. The PEAK push button toggles into/out of the Peak mode. High and low Peak values may be recalled any time without exiting the Peak mode or interrupting further peak recording. The following sequence is used:

RECALL HI PEAK

RECALL LO PEAK

The high or low peak value is latched in the display as long as the PEAK button is held depressed.

2-102. Exiting the Peak mode (toggle PEAK once) halts further peak recording, but does not erase previously recorded high and low values. A multimeter function change disables Peak mode and retains peak values. At any time, reentry into the Peak mode (toggle Peak again) erases previously recorded values. Both Peak mode and peak values are lost during a Power-Up or Reset condition.

2-103. LIMITS

2-104. The Limits mode may be employed to display a pass-fail indication of measurement values. The mode is entered when a single high or low limit value is stored, or when the LIMITS button is pushed. A second store sequence must be used if both high and low limits are desired. Either the normally displayed value or programmed numerics may be used for the limit values. For example, high and low limits of 12.05 and 11.95 would be programmed as follows:

STORE 1 2 . 0 5 HI

STORE 1 1 . 9 5 LO

In this example, the multimeter enters the Limits mode when either the HI or LO button is first pushed. Mode entry is verified by a display of HI, LO, or PASS. In this case, readings higher than 12.05 yield a HI display, readings lower than 11.95 yield LO, and all other readings yield PASS. The limit value(s) are compared to the now transparent display reading with all other parameters and operations still in effect.

2-105. A display reading can also be stored as a limit value. Use the following sequence:

STORE HI (or LO)

2-106. Use of Limits mode does not interrupt other uses of the multimeter. No measurement parameter or mathematic operation is changed: The other special operation (Peak) may be used simultaneously with Limits mode. Any of the measurement parameters or operations may be enabled, changed, or recalled while in the Limits mode: the display responds in the normal fashion during this process and automatically reverts to limits indications once the process is complete. Limits values may be recalled at any time (Limits mode enabled or disabled). The recall sequence does not change the state of the Limits mode. The following recall sequence is used:

RECALL HI LIMITS

RECALL LO LIMITS

The recalled value is latched in the display as long as the LIMITS button is held depressed.

2-107. Pushing the LIMITS button toggles the multimeter into or out of the Limits mode whether or not limits values have been entered. A function change disables the Limits mode, but retains any existing limit values. Once stored, limits values are retained during all but Power-Up and Reset sequences.

2-108. Remote Control

2-109. The multimeter may be equipped with any of three remote interface modules. These modules are fully explained in Section 6. When the -05 IEEE Interface is installed, the front panel LCL/RMT push button can be used to enable local control, but cannot be used to enable remote control. Remote control can only be commanded from the remote location with this interface.

2-110. The LCL/RMT push button may be used to toggle into/out of remote control when either the -06 Bit Serial or the -07 Parallel Interface is installed. Whenever the multimeter is in remote control, whether commanded locally or from the remote, the REMOTE annunciator is lighted.

2-111. When in remote, only the POWER push button remains operational at all times. The LCL/RMT push button may remain operational, but is disabled by a local lockout or display off command from the remote (refer to Section 6). A power interruption returns the multimeter to local control.

2-112. Calibration Mode

2-113. DESCRIPTION

2-114. The rear panel calibration switch is used to enable or disable the Calibration mode (remove calibration seal for access). The AVG/(CAL) annunciator flashes when the Calibration mode is enabled, or is lit steadily when the Averaging mode is enabled. Regular multimeter operation is significantly altered while in the Calibration mode:

1. Power must not be cycled on or off when the Calibration mode is activated (rear panel Calibration Switch on).

2. Overrange conditions no longer cause a special flashing “HHHHHH” indication.

3. Averaging mode is locked out: the Calibration and Averaging modes are mutually exclusive. However, pushing the AVG button when Calibration mode is on does enable or disable latching error indications.

4. All mathematic operations and special operations are disabled.

5. 7-1/2 digits are displayed on 10V dc range and 6-1/2 digits are displayed on all other functions and ranges. A sign (±) is displayed for all functions to facilitate potentiometer adjustment.

6. Calibration correction factors (for each range in V DC, A DC, OHMS, and for VAC ranges at a frequency of interest) and the calibration date may be stored.

2-115. Hardware calibration is facilitated while in Calibration mode. Enhanced resolution allows for more precise potentiometer adjustment during hardware calibration. With no mathematic operations allowed, the display represents the true input value.

2-116. Troubleshooting is also aided by using the Calibration mode. Latching errors can be disabled to allow special module configurations.

CAUTION

Latching errors are intended for multimeter protection and must not be disabled during normal operation or calibration. Refer to Troubleshooting in Section 4.

2-117. USE

2-118. The multimeter uses three calibration controls: the rear panel calibration switch, and the front panel (CAL DATE) and (CAL COR) push buttons. The rear panel calibration switch activates the Calibration mode and enables use of the (CAL COR) and (CAL DATE) push buttons. Store operations with these two push buttons are used for software calibration and are explained in Appendix 7B. Recall operations can be performed at any time and are explained in the following paragraphs.

2-119. The (CAL DATE) push button can be used in all functions to recall a six digit number. This number may signify the calibration date. For example, a recalled 0 2 1 8 8 3 would signify February 18, 1983. Alternately, the six digits may be used to identify the multimeter.

2-120. To recall the six digit date (or identifier) while in the Calibration mode, push RECALL (CAL DATE). If the multimeter is not in the Calibration mode, the six digit date (or identifier) can be recalled using RECALL LO (CAL DATE).

2-121. The (CAL COR) push button may be used to recall the uncorrected reading when the multimeter is in the Calibration mode, use:

RECALL (CAL COR)

The uncorrected reading can also be recalled when the multimeter is not in the Calibration mode. Use the following sequence:

RECALL LO (CAL COR)

2-122. Scan Advance

2-123. The multimeter outputs a sync signal during each measurement sequence. This signal occurs after the measurement is complete, but before a new trigger is accepted. The sync signal thereby allows for faster bus communications by advancing a scanner before a new reading is triggered. The signal (positive going TTL, 3 microsecond pulse width, 50-ohm output impedance) is available at a BNC connector on the multimeter rear panel.

2-124. Systems Use

2-125. The availability of optional interface modules makes the multimeter adaptable to a large variety of digital systems. Operating and programming instructions related to remote operation are included with the appropriate optional module.

2-126. OPERATION

2-127. Initial Turn-On

2-128. Before initial turn-on, check that the line voltage specified on the rear panel sticker (near the line fuse) agrees with the line voltage actually being used. If there is any doubt concerning the line voltage setting, refer to Line Voltage Selection in Section 4. Also verify that the Calibration switch is off. Once these verifications have been made, connect the power cord and push the POWER button to ON.

2-129. The multimeter identifies its own software and hardware at initial turn-on. Software is identified with a display of "HI - Y.Y.Y", where "Y" represents the software version in use. Hardware is then identified with a display of "CXXXXX", where "X" signifies any installed options by number.

2-130. Power-up (reset) configuration is now established. The function is set for V DC, the 1000V range is set, along with filter F0, sample 7, auto trigger, zero mode on, and local operation. All other modes and values are disabled, The multimeter may now be programmed as described in this Section. A two-hour warm-up insures rated accuracy. Better accuracies can be obtained in the Average mode after a four-hour warm-up.

2-131. Measurement Instructions

2-132. Use the following procedures when making measurements from the front panel:

1. Remove multimeter inputs.
2. Select the desired function.
3. Referring to Figure 2-3, set measurement parameters.
4. Further programming from the front panel is often not necessary. If no mathematic operation or special operations are desired, proceed to Step 6.
5. If mathematic or special operations are desired, refer again to the guidelines in Figure 2-3.
6. Position the measurement terminal controls (right of terminals) as required. The Rear Input Selector must be disengaged (out) if the front panel inputs are being used. The Ohms Selector must be engaged (in) when four-wire resistance measurements are being made. The Guard Selector is normally left disengaged (out) for non-critical measurements. Refer to Measurement Terminals and Controls in this Section for other uses of these selectors.

7. Depending on the function selected, make the measurement connection illustrated in Figure 2-5.

2-133. APPLICATIONS

2-134. Specific applications using the multimeter are presented in Table 2-6. The applications may be used as examples to aid in familiarization with the multimeter. If the applications are duplicated, modes or values already programmed could interfere with the expected instrument response. Therefore, a power-up or reset instrument configuration is a precondition.

Table 2-6. Applications

STORING A DISPLAYED VALUE

$$\text{STORE} \longrightarrow \left\{ \begin{array}{l} \text{OFFSET} \\ \text{SCALING} \\ \text{HI} \\ \text{LO} \end{array} \right.$$

APPLICATION 1

REQUIREMENT: Monitor the stability of a power supply in terms of its deviation in volts from a present output of +5.03V.

METHOD: Store the present output as an offset. Press:

STORE ⟶ OFFSET

Offset is now enabled. The multimeter will read only the deviation from +5.03V.

APPLICATION 2

REQUIREMENT: Monitor the stability of a power supply as a decimal ratio to its present reading of - 20.08V. DC zeroing appears to be necessary.

METHOD: Perform V DC Zeroing for internal drift. Apply low thermal short between INPUT HI and LO (at the terminals). Press:

ZERO
VDC/Ω

The value stored will be displayed as long as ZERO VDC/Ω is held depressed. Release of the switch will activate the Zero mode. Revise terminal interconnections for dc volts measurements. Connect the dc voltage.

Apply power supply reading of -20.08V as a scaling factor. Press:

STORE ⟶ SCALING

Display will now yield the ratio of subsequent readings to the scaling factor, e.g., an input of 22.08V yields a ratio of:

$$\frac{22.088}{20.08} = 1{:}1$$

STORING A NUMERIC ENTRY

$$\text{STORE} \left\{ \begin{array}{l} \longrightarrow \text{ 0 - 17 } \longrightarrow \text{SAMPLE} \\ \longrightarrow \text{ —,0,1,2,3 } \longrightarrow \text{FILTER} \\ \longrightarrow \text{ (VALUE) } \longrightarrow \left\{ \begin{array}{l} \text{OFFSET} \\ \text{SCALING} \\ \text{HI} \\ \text{LO} \end{array} \right. \end{array} \right.$$

Table 2-6. Applications (cont)

APPLICATION 3	
REQUIREMENT:	Identify the power supplies that have a tolerance of 15V ±100 mV.
METHOD:	Set high and low limits. Press: STORE → 1 → 5 → . → 1 → HI STORE → 1 → 4 → . → 9 → LO The multimeter will now display "HI," "LO", or "PASS" for each power supply.
APPLICATION 4	
REQUIREMENT:	For a group of 20V power supplies, determine the deviation in volts.
METHOD:	Offset the displayed reading by 20. Press: STORE → 2 → 0 → OFFSET Any value displayed now will equal the deviation from 20V.
APPLICATION 5	
REQUIREMENT:	Display the input error voltage for an operational amplifier by measuring the dc output error. Gain = 2.6847 x 10^4.
METHOD:	Divide the measured dc output error by a scaling factor (the op amp gain). Press: STORE → 2 → . → 6 → 8 → 4 7 → EXP → 4 → SCALING The multimeter will now divide the measured input by the gain of the op amp and display the input error voltage.
APPLICATION 6	
REQUIREMENT:	Make a series of measurements in a noisy environment. Speed of measurement is not important. Display only the deviation in volts.
METHOD:	Allow for extra settling between readings: Press: STORE → 3 → FILTER Increase digital filtering (average more samples per reading). Press: STORE → 9 → SAMPLE Offset by the nominal output (e.g., 15V). Press: STORE → 1 → 5 → OFFSET

Table 2-6. Applications (cont)

RECALLING

$$\text{RECALL} \longrightarrow \left\{ \begin{array}{l} \text{OFFSET} \\ \text{ZERO VDC/}\Omega \\ \text{EXT REF} \\ \text{SAMPLE} \\ \text{SCALING} \\ \text{FILTER} \\ \left. \begin{array}{l} \text{HI} \\ \text{LO} \end{array} \right\} \longrightarrow \left\{ \begin{array}{l} \text{PEAK} \\ \text{LIMIT} \end{array} \right. \end{array} \right.$$

APPLICATION 7

REQUIREMENT:	Determine the highest and lowest readings encountered in measuring a group of 28V power supplies.
METHOD:	Press PEAK to record measurement extremes. Use a manual trigger for each measurement. When required measurements are complete, use the following sequence to recall high and low values. Press: RECALL → LO → PEAK RECALL → HI → PEAK (Hold PEAK in to read the recorded values.)

Section 2A
Remote Programming Commands

2A-1. INTRODUCTION

2A-2. This section documents remote operation of the multimeter with any of the following interface modules installed:

1. IEEE-488 Interface (Option -05)
2. Bit Serial Interface (Option -06)
3. Parallel Interface (Option -07)

2A-3. Basic remote operation for 8500 series multimeters is detailed in Table 2A-1. These operating features are generally compatible with the 8505A and 8506A multimeters. Table 2A-2 details additional remote operating features available with the 8505A and 8506A only.

2A-4. General information, theory of operation, maintenance information, parts lists, and schematic diagrams for each of the three remote interfaces are presented in Section 6 of this manual.

2A-5. Software calibration for each function can be accomplished locally or remotely. Complete software calibration information is presented in Appendix 7B of this manual.

Table 2A-1. Programming Instructions

The programming instructions in this table pertain to the 8500 Series Digital Multimeters with the IEEE-488 Interface (Option -05), the Bit Serial Interface (Option -06) or the Parallel Interface (Option -07) installed. Features and instructions unique to the DMM model or to the Interface used will be identified in the following manner:

1. 8500A or 8502A: the symbol ◆ will denote an explanation applicable to one DMM model only. The software version incorporated in the DMM may also be mentioned for further identification. To verify the software version incorporated in your instrument, observe the display indication at power on or reset. For example, in the 8502A, "HI-2.0.2" will appear in the display for models with software version 2.0.2.

2. -05, -06, or -07 Interface Options: the symbol ● will be used with a feature or instruction unique to a particular Interface.

INITIALIZATION

When power is applied, or the Reset character (*) is transmitted, the instrument assumes a preset default condition. This condition is defined by the following remote codes:

	REMOTE CODE	COMMAND
	V	Volts DC
	R4	1000V range
◆	S5 (8500A)	2^5 Samples per Reading
◆	S7 (8502A)	2^7 Samples per Reading
	F0	Fast Filter, Timeout Disabled (Panel Indicator OFF)
	X0	External Reference/Scaling Disabled
	P0	Offset Feature Disabled
	U0	Limits-Peak Value Storage Disabled
	T0	Single Reading Line Synchronous
	B0	Single Character ASCII Format
	D0	Front Panel Display Active
	L0	Deactivate Local Lockout
	J0	Deactivate Line Feed Suppression
	M0	Enable Cal Memory Factors
◆	Q0 (8502A)	Disable External Trigger
◆	W (8502A)	No Delay
●	Y0 (-06 Option only)	Echo mode off (Bit Serial IF)

In addition, the following instrument states are assumed at power on or Reset:

	Remote/Local	Local
	Offset	Zeroed
	V dc Zero	Zeroed or *
	Ohms Zero	Zeroed or *
	Cal Memory Factors	*
	Peak Values	Cleared
	Limits Values	Zeroed
	Ext. Ref/Scaling Values	1
●	8/16 Bit Mode (-07 Option only)	8 Bit

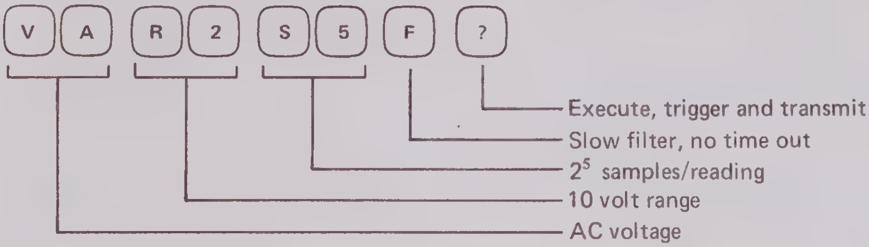
*Retained if Cal Memory Option -04 installed

Table 2A-1. Programming Instructions (cont)

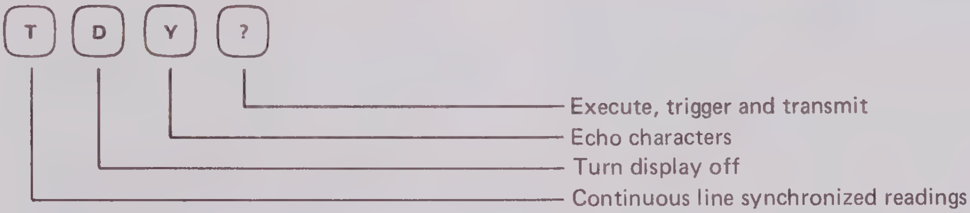
PROGRAM SEQUENCE

When equipped with a remote interface option, the instrument is programmed through a sequence of commands ("command string") that will determine range, function, reading rate, etc. Examples of 5 possible command strings are:

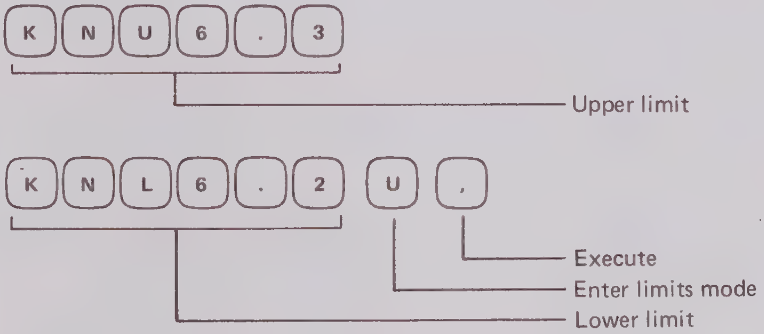
1.


V A R 2 S 5 F ?
Execute, trigger and transmit
Slow filter, no time out
2^5 samples/reading
10 volt range
AC voltage

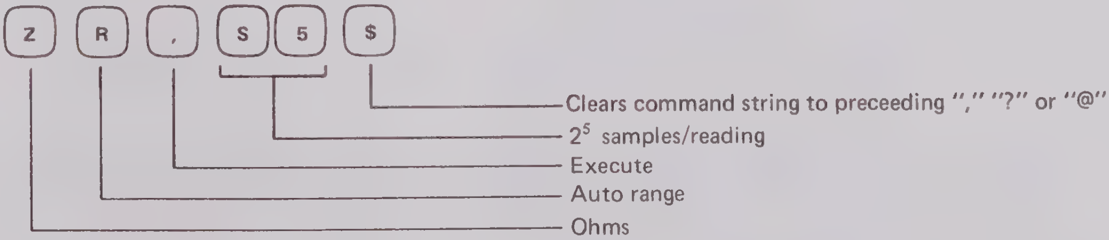
2.


T D Y ?
Execute, trigger and transmit
Echo characters
Turn display off
Continuous line synchronized readings

3.


K N U 6 . 3
Upper limit
K N L 6 . 2 U ,
Execute
Enter limits mode
Lower limit

4.


Z R , S 5 $
Clears command string to preceeding "," "?" or "@"
2^5 samples/reading
Execute
Auto range
Ohms

5.

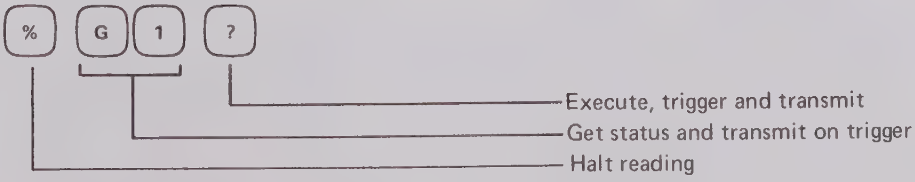

% G 1 ?
Execute, trigger and transmit
Get status and transmit on trigger
Halt reading

Table 2A-1. Programming Instructions (cont)

All command string characters transmitted via the remote interface must be ASCII 7-bit upper case characters. A command string is a sequence of 1 to 31 characters. Characters are classified as immediate, command or termination. The instrument may be placed in Remote mode by toggling the front panel REMOTE switch or by transmitting any character that the instrument will recognize from the remote controlling terminal.

● With the IEEE Interface installed, the REMOTE switch can only be used to select local mode if already in Remote.

REMOTE is the only front panel switch to remain active when in REMOTE mode; REMOTE may, however, be locked out by the local lockout command.

IMMEDIATE CHARACTERS

There are 5 immediate characters; each of these may be executed at any time and does not require a termination character.

*	**Reset**	This immediate character will reset the instrument to the conditions described under INITIALIZATION. ◆ When transmitted, the reset character must not be followed by any other character for 3 seconds with the 8502A (2 seconds with the 8500A). Any carriage return or line feed following the reset character must be suppressed. The remote interface will be unable to accept programming characters during this time.
%	**Halt**	The halt character is used to terminate the continuous mode and cause the instrument to wait for a command string. No other characters should precede the halt character if continuous mode is in effect. Upon receipt of the halt character, the transmission of readings is terminated immediately. The following trigger mode transitions will occur when halt is used: From: Continuous Line Synchronous To: Single Reading Line Synchronous From: Continuous Asynchronous To: Single Reading Asynchronous
#	**Go To Local - Lock Out Remote**	● This character will command the instrument (Options -06 or -07 only) to enter local mode of operation and lock out the remote interface. ● The Remote mode may then be reentered by pressing the front panel REMOTE switch (for Option -06, -07). The Remote mode may not be reentered from the front panel when using the IEEE-488 Interface (Option -05).

Table 2A-1. Programming Instructions (cont)

**Go To Local-Lock Out Remote (cont)**

The state of the instrument, when changing from remote to local operation will be modified as follows:

1. Ohms fast mode will be ignored.
2. ◆ Scaling mode will not be in effect (8500A only).
3. ◆ If the high averaged samples per reading rate was in effect, the samples per reading will be set to 2^7 (8500A only).

The state of the instrument when changing from local to remote operation will be modified as follows:

1. Ohms fast mode (Z1) and continuous reading mode will be resumed if the DMM was in either mode when place into local.
2. Any error that occurred during local operation will be stored and available for recall.

! **High Speed Reading Mode**

● The "!" character can be used with the Parallel Interface (Option -07) (and with the IEEE-488 Interface Option -05 in the 8502A only). The High Speed Reading mode provides a shortened 3-byte binary two's complement format response representing the input to the DMM's A/D Converter. Speeds up to 500 readings per second are possible in this mode of operation.

True readings can be computed from this response using range and function dependent factors (refer to Fluke Application Bulletin 25).

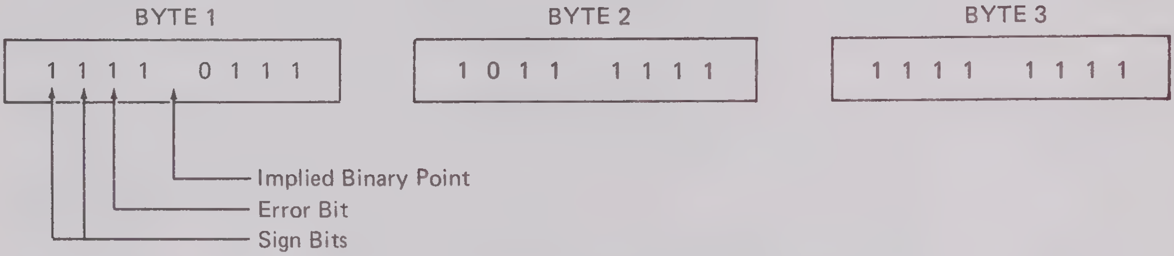
The High Speed Reading mode is suited to systems with very fast processors, to use with stored readings, or to applications not requiring direct numeric conversions (e.g., zero crossings or large deviations from a nominal value).

◆ Use of the "!" character will place the DMM in the High Speed Reading mode and trigger the first reading. Subsequent readings can be triggered by sending the "?" character. In addition, for the 8502A equipped with the -08A Option, subsequent readings can be triggered by sending the TTL pulse with the External Triggering Mode ("Q" or "Q1"). The High Speed Reading mode can be aborted at any time by transmitting a character other than "?" when a reading is to be triggered. The character sent in this case will do nothing more than cause the DMM to exit the High Speed Reading mode.

Table 2A-1. Programming Instructions (cont)

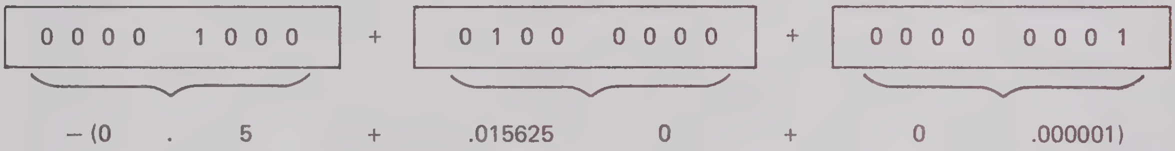
Voltage and Current Reading in "!"

The response data from the DMM will be in 3-byte format, as shown below, for each voltage or current reading. The first byte of this response contains sign and error bits, an implied binary point, and an implied scale factor of ten. Bytes 2 and 3 further define the reading. If the reading is negative, the sign bits will equal "1", and all three bytes must be two's complemented before conversion. If the error bit is equal to the complement of the sign bit, an error is defined.



In this example, the sign bits are "1" and the reading is negative. Since the complement of the sign bit does not equal the error bit ("1"), no error is defined.

To convert the response in this example, the two's complement must first be formed.



= 0.515626 X 10 (the implied scale factor)

Further conversion to calculate the true reading Rt necessitates multiplication of the A/D Converter reading (RAD) by the scale factor for the instrument's range and function.

$[R_t = R_{AD} \text{ X Scale Factor}]$

Ohms Readings in "!"

The procedure for measuring ohms in High Speed Reading mode is more complex. High Speed Ohms readings differ from Fast Ohms (Z1) readings; when using the "!" character, the DMM will not compute the true reading. This conversion must be performed by the user. Up to 500 readings a second are possible when using High Speed Ohms. Refer to OPERATING NOTES, provided with Option -05 and -07 for High Speed Ohms Reading procedures.

/ **8/16 Bit Toggle**

The "/" character is used tó toggle between the 8-bit and the 16-bit mode. When this character is used to toggle from one mode to another, the immmediate and/or termination character must be placed in the least significant byte (LSB) of the programming word.

Table 2A-1. Programming Instructions (cont)

TERMINATION CHARACTERS

Termination characters cause the execution of a command string. They are normally placed at the end of each programming statement.

$	**Clear the Command String**	● (Normally used only with the Bit-Serial Interface -06 Option.) This character is used to erase an incorrect programming entry from the command string buffer, deleting all characters issued back to, but not including, the preceding termination character. A new command string is then needed to modify the state of the instrument.
,	**Execute the Command String**	This character is used to cause the execution of the previous command string. The instrument will then be in the defined state only; the character will not trigger a reading or produce a response from the instrument. When programming a string of characters, it is recommended that the execute character be used at frequent intervals; if an error is made, the string need then be cleared only back to the last execute character. This execute character is also required if a command string longer than 31 characters is used.
?	**Execute the Command String and Trigger**	This character will cause three actions: any previously entered command string will be executed, a reading will be taken, and that reading will be transmitted through the remote interface. If a command string was not entered immediately preceding this character, the instrument will take and transmit a reading in the last defined state. An exception occurs when a command string containing a "Get" command has been entered; the instrument will then respond with the value or status that was requested by the command string (no reading will be triggered). When issuing a program string terminated by the "?" character, the "CR" and/or "LF" delimiter characters should be, but do not have to be suppressed. If an error occurs during the reading, a single "0", followed by a "CR", will be transmitted. At this point, status should be requested to determine the cause of the error.
@	**Execute, Trigger, and Interrupt when Ready**	This character is used to trigger a reading and generate an interrupt when the reading is complete.

Table 2A-1. Programming Instructions (cont)

@ **Execute, Trigger, and Interrupt when Ready (cont)**

- To provide the interrupt, the Bit-Serial Interface (Option -06) and the Parallel Interface (Option -07) transmit a single "CR". The IEEE-488 Interface (Option -05) provides an interrupt by generating a service request (SRQ).

The reading triggered by the "@" character can be obtained by inserting a "G" (get) command in the following command string (terminated by a "?").

> *The "@" character and the IEEE-488 Bus command "Group Execute Trigger" perform the same function.*

COMMAND CHARACTERS

Command characters are classified within the following five groups:

1. FUNCTION
2. RANGE
3. MODIFIERS
4. CONTROL
5. MEMORY

FUNCTION COMMAND CHARACTERS

There are 7 function command characters. Whenever one of these characters is used, the state of the instrument will be changed as follows:

RANGE	Auto
MODIFIERS	Offset, Scaling, Limits, Peaks modes are turned off; stored values for these modes are retained.
MEMORY, CONTROL	Unchanged

If a function is selected requiring an optional module which is not loaded, the function of the instrument will be undefined, and the error code will be set to 19.

V **DC Volts**

V A **AC Volts**

C **DC Coupled AC Volts**

I **DC Current**

I A **AC Current**

Table 2A-1. Programming Instructions (cont)

Z **Ohms**

Z **1** **Fast Ohms**

The Z1 character will place the instrument into the ohms function and the fast ohms mode. In normal ohms operation, the unknown resistor value Rx is computed from the following measurements:

> V1-V2: the voltage across an internal precision resistor (Rr)
>
> V0: the voltage across the unknown resistor (Rx).

The value of Rx is then computed with Ohm's Law:

$$Rx = Rr \quad \frac{V0}{V1\text{-}V2}$$

Fast Ohms mode differs in that the value of $\frac{Rr}{(V1\text{-}V2)}$ is stored as a constant. The instrument will the find Rx by measuring V0 and multiplying this constant. The constant will change with a function change, range change or overload condition.

NOTE

Fast ohms ("Z1") differs from HIGH SPEED READING ("!"). When using "!" for ohms measurement, Rx is not computed by the DMM.

RANGE COMMAND CHARACTERS

The nine range commands specify the following maximum values by function.

	DC VOLTS	VA or C AC VOLTS	I or IA DC or AC CURRENT	Z or Z1 OHMS
R	Auto	Auto	Auto	Auto
R 0	312 mV	Auto	312 μA	31.25Ω
R 1	2.5V	2.5V	2.5 mA	250Ω
R 2	20V	20V	20 mA	2 kΩ
R 3	160V	160V	160 mA	32 kΩ
R 4	1200V	1000V	1.28A	256 kΩ
R 5	Auto	Auto	Auto	4.096 MΩ
R 6	Auto	Auto	Auto	32.768 MΩ
R 7	Auto	Auto	Auto	262.144 MΩ

Table 2A-1. Programming Instructions (cont)

MODIFIER COMMAND CHARACTERS

SAMPLES PER READING COMMAND CHARACTERS

The modifier command character "S" or "H" specifies the number of samples taken per reading. The times shown for these characters are approximate digitizing times per reading for 60 Hz line synchronous operation in dc volts, ac volts or current function.

S	0	$2^0 = 1$ Sample/Reading (4 ms)
S	1	$2^1 = 2$ Samples/Reading (8 ms)
S	2	$2^2 = 4$ Samples/Reading (17 ms)
S	3	$2^3 = 8$ Samples/Reading (33 ms)
S	4	$2^4 = 16$ Samples/Reading (67 ms)
S	5	$2^5 = 32$ Samples/Reading (134 ms)
S	6	$2^6 = 64$ Samples/Reading (267 ms)
S	7	$2^7 = 128$ Samples/Reading (534 ms)
H	0	$2^8 = 256$ Samples/Reading (1.1s)
H	1	$2^9 = 512$ Samples/Reading (2.1s)
H	2	$2^{10} = 1,024$ Samples/Reading (4.3s)
H	3	$2^{11} = 2,048$ Samples/Reading (8.5s)
H	4	$2^{12} = 4,096$ Samples/Reading (17.1s)
H	5	$2^{13} = 8,192$ Samples/Reading (34.1s)
H	6	$2^{14} = 16,384$ Samples/Reading (68.3s)
H	7	$2^{15} = 32,768$ Samples/Reading (137s)
H	8	$2^{16} = 65,536$ Samples/Reading (273s)
H	9	$2^{17} = 131,072$ Samples/Reading (546s)

Table 2A-1. Programming Instructions (cont)

FILTER COMMAND CHARACTERS

The "F" character is used to specify the type of filtering and the enabling of a time-out (for the filter settling time). This time-out causes a delay between a trigger command received and the actual reading taken. In the continuous trigger modes, the time-out will occur before each reading is initiated. The following "F" modifier command characters are used:

F	**Slow filter, time-out disabled.**
F 0	**Fast filter, time-out disabled.**
F 1	**Bypass filter.**
F 2	**Slow filter, time-out enabled (approximately 500 ms).**
F 3	**Fast filter, time-out enabled (approximately 50 ms).**

TRIGGER COMMAND CHARACTERS

The "T" characters specify the instrument's trigger mode. These characters determine whether samples taken are line synchronous (every 4 or 5 ms) or line asynchronous (approximately every 1.7 ms), whether single or continuous readings are to be taken.

T	**Continuous reading mode/line synchronized.**
T 0	**Single reading mode/line synchronized.**
T 1	**Continuous reading mode/line asynchronous.**
T 2	**Single reading mode/line asynchronous.**

NOTE

When line asynchronous modes are selected, the display will be turned off to save time; the front panel switches are then ignored.

◆ When in the continuous mode, any character (except "%" HALT) will be ignored by the instrument (8502A).

When in the Single Reading mode ("T0" or "T2"),and IEEE Group Execute Trigger command, a "?" or "@" character, or a TTL trigger (for the 8502A-08A) must be sent for each reading.

With the Continuous Reading mode ("T" or "T1"), use of the "GET" command, "?", "@" or a TTL trigger will start continuous readings.

Table 2A-1. Programming Instructions (cont)

When each reading is accepted by the instrument controller, the next reading will be started. An exception to this sequence occurs in the "J1" Suppress Output mode; the next reading will now be taken immediately, without waiting for the output to the controller.

NOTE

The front panel display does not update in this mode unless the controller asks for a reading.

Use of the "%" character will halt the Continuous Reading mode and cycle the unit back to the Single Reading mode.

OFFSET COMMAND CHARACTERS

The "P" command characters specify whether an offset will be subtracted from a reading. The offset value may be entered by storing either a previous reading or a numerically entered offset.

◆ When storing readings, the 8500A will store the unprocessed reading, and the 8502A will store the displayed value.

Offset values may range from $\pm 1 \times 10^9$ to $\pm 1 \times 10^{-9}$ (including 0.0).

[P] **Offset subtracted (ON).**

[P] [0] **Offset not subtracted (OFF).**

EXTERNAL REFERENCE AND SCALING COMMAND CHARACTERS

The "X" command characters select External Reference or Scaling mode. Either mode is valid for any function and range. In External Reference mode, readings are divided by the signed magnitude of the external reference voltage. In Scaling mode, readings are divided by a numerically entered scale factor or by a previously read value.

[X] **External Reference On, Scaling Off**

The "X" External Reference mode uses the external reference voltage (Vxref) to divide the measured voltage. Vxref is measured during each reading cycle.

◆ Minimum Vxref = ±0.0001V or the input divided by the maximum display with the volts range, whichever is greater (8500A only).

◆ For the 8502A, the minimum Vxref is the input divided by 10^9.

Maximum Vxref = ±40V between Ext Ref Hi and Lo terminals, providing neither terminal is greater than ±20V relative to the Sense Lo or Ohms Guard Terminals.

Table 2A-1. Programming Instructions (cont)

X 0 **External Reference Off, Scaling Off**

X 1 **External Reference Off, Scaling On**

The "X1" Scaling mode will divide all readings by a previously taken external reference voltage or by a previously entered numeric scale factor. The read valued may not be used as a scaling factor.

NOTE

The 8502A can store the external reference voltage and the numerical scale factor separately. The 8500A can only store one or the other, not both.

◆ Minimum scaling factor = the same as the minimum Vxref, for the 8500A.

◆ For the 8502A minimum = 10^{-9}. Factors less than this will be set to 0, which is not a valid scale factor.

Maximum scaling factor = ±100 (8500A), or Input/Max Scale factor $<10^{-9}$ (8502A).

NOTE

The "X" and "X1" modes are mutually exclusive.

LIMITS AND PEAKS COMMAND CHARACTERS

The "U" command characters specify selection of Limits or Peaks modes.

U **Limits Testing On**

When this command character is sent, each instrument reading is compared to upper and lower limits. Limit values must be entered separately with a keep command (refer to KEEP COMMAND CHARACTERS). The output format from the instrument (when given a "G" command) is as follows:

"0" is transmitted for a reading within limits.

"1" is transmitted for a reading greater than the upper limit.

"-1" is transmitted for a reading less than the lower limit.

"2" is transmitted if an error occurs (e.g., overranging).

U 0 **Disable Limits and Peak Mode(s)**

U 1 **Save Highest and Lowest Values (Peaks On)**

Previous peak values are erased from memory whenever the "U1" command character is programmed.

Table 2A-1. Programming Instructions (cont)

U 1 **Save Highest and Lowest Values (Peaks On) (cont)**

◆ For the 8500A, storage of limit and peak values are mutually exclusive. For the 8502A, limit and peak values can be held in memory simultaneously.

NOTE

Limits are applied after all other modifier operations (Scaling, Offset, etc.) have been performed.

CONTROL COMMAND CHARACTERS

Output Format

The "B" characters activate binary or ASCII output format.

B **Single Byte Binary Format**

B 0 **Single Byte ASCII Format**

● B 1 **Binary 16-Bit Parallel**

● B 2 **16-Bit Parallel**

"B1","B2" used with Paralled ASCII Interface (Option -07) only.

The front panel DMM display is turned on when the ASCII mode is entered and off when the binary mode is entered.

The Binary Output Format

The binary output format consists of five bytes. The first four bytes comprise a 32-bit binary two's complement fixed point number. An implied binary point for this number is located between the first and second bytes. The first 8-bit byte thus serves as the integer portion. The 24 bits of the next 3 bytes serve as the binary fraction. Additionally, since this format cannot be used to hold the entire range of possible values for the DMM, a fifth byte is used as an exponent. This exponent is a two's complement binary number representing the decimal exponent of the binary fixed point number defined by the first 4 bytes. An exception occurs in Limits testing; the response will then be single byte binary two's complement number.

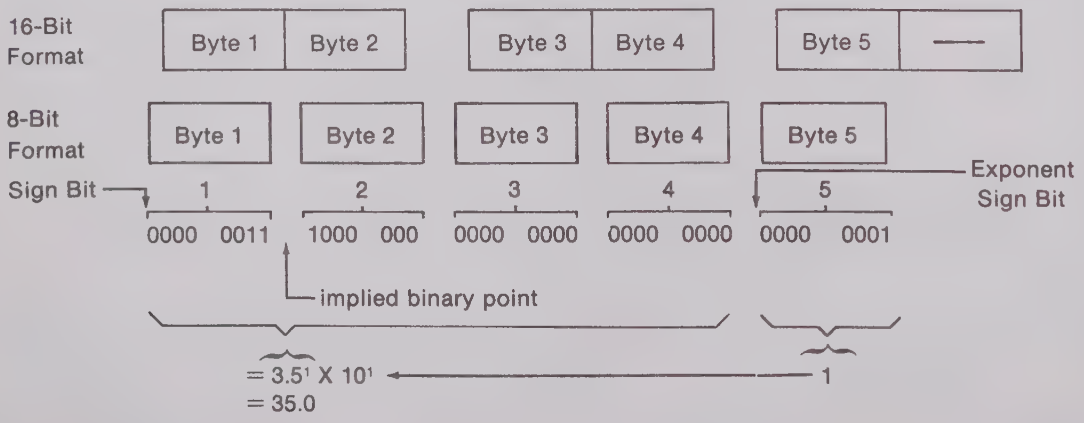

16-Bit Format
Byte 1
Byte 2
Byte 3
Byte 4
Byte 5
——
8-Bit Format
Byte 1
Byte 2
Byte 3
Byte 4
Byte 5
Sign Bit
1
2
3
4
5
Exponent Sign Bit
0000 0011
1000 000
0000 0000
0000 0000
0000 0001
implied binary point
= 3.5¹ X 10¹
= 35.0
1

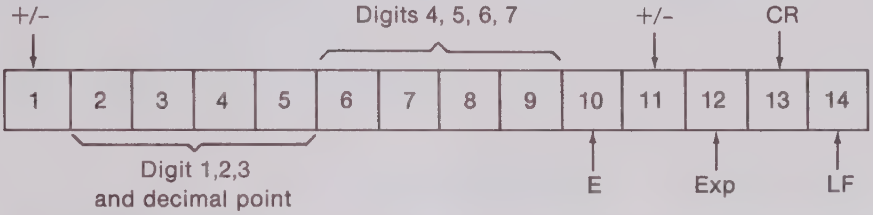
Table 2A-1. Programming Instructions (cont)

NOTE

In dc volts and ac volts, the exponent is always 1. In dc and ac current, the exponent is always -2. The exponent is range dependent in ohms function (1 for ohm ranges, 4 for kohm ranges, and 7 for Mohm ranges).

Errors will be indicated by 5 bytes of 0.

ASCII Data Output Format



The seventh digit in the ASCII format corresponds to the "Cal" or HIRES digit of the front panel display. In some ranges and functions (e.g., 100 mV dc) this digit is permanently zeroed since it exceeds the resolution of the instrument. (When in the "Cal" or HIRES mode, the front panel will display the value of the reading rounded to six significant digits.)

DISPLAY CONTROL

The "D" command characters turn the DMM front panel display on or off.

D **Display Off**

D 0 **Display On**

When the "D0" command is used, the instrument will no longer interrogate any of the front panel switches (local lockout). The display will be turned On when the ASCII output format is commanded.

LOCAL LOCKOUT CONTROL

The "L" command characters select the local lockout condition, in which the display remains activated while none of the front panel switches affect the instrument.

L **Local Lockout On**

L 0 **Local Lockout Off**

ECHO COMMAND CHARACTERS
● (used with Bit Serial Option -06 only)

Y **ECHO ON (Full-Duplex)**

Y 0 **ECHO OFF (Half-Duplex)**

Table 2A-1. Programming Instructions (cont)

LINE FEED CONTROL COMMAND CHARACTERS

J	**Suppress Line Feed Character**	This character suppresses the LF character normally sent at the end of a response line.
J 0	**Transmit Line Feed Character**	This character disables the "J" character; the "LF" character will be sent.
J 1	**Suppress Output of Readings**	◆ In the 8500A, use of J1 will suppress all output from the DMM. In the 8502A, use of J1 will suppress output with the following exceptions: Service Request (SRQ), status, recalled values. While in the J1 mode, use of the recall command "G ?" will retrieve a reading. Use of "J" or "J0" will exit the "J1" mode.

CALIBRATION CONSTANT

When the Calibration Memory (Option -04) module is installed, the "M" character will inhibit the adjustment of readings by the Calibration Memory correction factor. A slight increase in the speed of readings will result.

M	**Inhibit Calibration Memory Factors**
M 0	**Enable Calibration Memory Factors**

TRIGGER COMMAND CHARACTERS

◆ This set of command characters is available for the 8502A with the Isolator Option -08A.

Q	**Activate External Triggering Mode, Interrupt when Ready**	This character enables the External Triggering mode. Any external TTL trigger then initiates a reading and interrupts when ready (SRQ).
Q 0	**Deactivate External Triggering Mode**	
Q 1	**Activate External Triggering Mode, Transmit when Ready**	The Q1 character also enables External Triggering mode. Any external TTL trigger initiates and transmits a reading.

NOTE

The "?" and "@" characters remain operative during External Triggering.

Table 2A-1. Programming Instructions (cont)

◆ EXTERNAL TRIGGER DELAY COMMAND CHARACTERS
(-08A with 8502A only)

The "W" command characters select the amount of delay between the external trigger signal and the initiation of the reading.

W	**No Delay**
W 0	**2.083 ms**
W 1	**4.166 ms**
W 2	**8.332 ms**
W 3	**16.66 ms**
W 4	**33.33 ms**
W 5	**66.66 ms**
W 6	**133.3 ms**
W 7	**266.6 ms**
W 8	**533.2 ms**
W 9	**1.066s**
W 1 0	**2.133s**
W 1 1	**4.266s**
W 1 2	**8.532s**
W 1 3	**17.06s**
W 1 4	**34.13s**
W 1 5	**68.26s**

Table 2A-1. Programming Instructions (cont)

MEMORY COMMAND CHARACTERS

STORE

The "K" (Keep) command characters specify the storing of a reading or numeric entry.

K	**Store Last Reading as Offset**	◆ The 8500A will store the unprocessed reading, whereas the 8502A will store the displayed reading.
K 0	**Store Last Voltage Taken as VDC Zero (on R0 Only)**	
K 1	**Store Last Reading as Ohms Zero (on R0 Only)**	
K N P	**Store Numeric Value Following as Offset**	
K N X	**Store Numeric Value Following as Scaling Factor** *(Note: The read value may not be stored as a Scaling Factor.)*	
K N U	**Store Numeric Value Following as Upper Limit**	
K N L	**Store Numeric Value Following as Lower Limit**	

Offsets, Scaling Factors, Upper and Lower Limits may be entered via the "KN" command characters, followed by one of the modifier characters "P", "X", "U" or "L" and the numeric value (on ASCII string of numeric characters, and optional sign, decimal point and signed decimal exponent digit in "E" notation).

Examples of legal numeric strings are:

K N P 1 0

Keep Numeric offset of 10.0

K N X 1 0 . 3 E - 1

Keep numeric scaling factor of 10.3 X 10^{-1} or 1.03

K N U 7 . 6 E 4

Keep numeric upper limit of 7.6 X 10^{4}

K N L - 1 2 3 . 4 5 6 E + 0

Keep numeric lower limit of –123.456

Table 2A-1. Programming Instructions (cont)

An example of an illegal numeric string is:

K N X 2 . 0 E - 1 3

Exponent is limited to one signed integer digit, in this case the exponent would be -1 and the "3" would be ignored.

NOTE

Numeric entries are limited to the maximum display value. These values are:

+1.00000 E +9 to +1.00000 E -9, and -1.00000 E -9 to -1.00000 E +9

Numbers less the ±1.00000 E -9 are treated as zero.

RECALL

The "G" (Get) command characters specify the recall of a reading, a numeric entry or a status. Each "Get" command must be followed by a "?" termination character. The following memory "Get" commands may be used:

G **Recall Previous Reading and Send on Next Trigger**

G 0 **Recall DC Zero and Send on Next Trigger**

G 1 **Recall Status and Send on Next Trigger**

Status information from the DMM may be obtained with the command character "G1?". The status response will be returned in the following seven character format.

Error Codes

1	2					

Characters 1 and 2 define error code status. Each error code contains two digits: those codes with a zero for the first digit are related to remote operation only. All other codes contain the same second digit as the DMM's front panel error codes.

	00	No Error
	06	System Error
	07	Illegal Numeric Entry
	08	Remote Command String Error
	09	Remote Overrange
	10	V DC Zero/Ohms Zero Error
◆	11	Offset Error (8500A) Store during Overrange (8502A)

Table 2A-1. Programming Instructions (cont)

Error Codes (cont)

12	Filter Module Faulty or not installed
13	DC Signal Conditioner Module Faulty or not installed
14	Excessive voltage present at terminals for Ohms/Current Measurement
15	Fast A/D Converter Faulty or not installed
16	Numeric Display Overflow
17	Magnitude of External Reference Input >20V
18	Controller Module Faulty
19	Function Module selected not installed

Range Codes

		3				

The third character of the status response contains the following range information:

0	100 mV dc, 100 μA, 10Ω
1	1V dc, 1V ac, 1 mA, 100Ω
2	10V dc, 10V ac, 10 mA, 1kΩ
3	100V dc, 100V ac, 100 mA, 10 kΩ
4	1000V dc, 1000V ac, 1A, 100 kΩ
5	1 MΩ
6	10 MΩ
7	100 MΩ

Sample Codes

			4			

The fourth status response character contains sample information identified by the following codes:

0	1 Sample per Reading
1	2 Samples per Reading
2	4 Samples per Reading
3	8 Samples per Reading
4	16 Samples per Reading
5	32 Samples per Reading
6	64 Samples per Reading
7	128 Samples per Reading or Greater

Function Codes

				5	<CR>	<LF>

The fifth response character identifies function:

0	DC Volts
1	AC Volts
2	DC Amps
3	AC Amps
4	Ohms
5	DC Coupled AC Volts
7	Function Not Defined

Table 2A-1. Programming Instructions (cont)

G N P	**Recall Offset and Send on Next Trigger**
◆ G N X	**Recall External Ref or Scaling Factor and Send on Next Trigger (8500A)** **Recall Scaling Factor (8502A)**
◆ G N R	**Recall External Reference Factor and Send on Next Trigger (8502A)**
G N U	**Recall Upper and Send on Next Trigger**
G N L	**Recall Lower Limit and Send on Next Trigger**

NOTE

The instrument will replay to "GNU" or "GNL" by transmitting the stored limit value.

G N Q	**Recall Lowest (Peak) Value Found and Send on Next Trigger**
G N W	**Recall Highest (Peak) Value Found and Send on Next Trigger**

Table 2A-2. Programming Instructions (8505A, 8506A)

The following discussion relates remote operation features available with the 8505A and the 8506A to existing documentation for remote operation of the 8500 series multimeters. The additional features for the 8505A and the 8506A are presented in this discussion in the same sequence as they would appear in the "Programming Instructions" table (Table 2A-1).

Most of the items documented in this table supplement features available with the 8502A and 8502A/AT. Incompatibilities have been kept to a minimum. Therefore, programs designed for the 8502A are generally compatible with the 8505A and the 8506A, and 8502A/AT programs are generally compatible with the 8506A. The few areas that are not compatible are briefly described below. Refer to appropriate areas in this table for a more detailed description.

1. High Speed Mode (!): Some High Speed mode scaling factors have been changed. Also, use of the reset command (*) causes the multimeter to both exit High Speed mode and perform a normal reset.
2. Range Commands: Full scale points and autoranging points have been changed in several instances.
3. Store Zero Commands (K0, K1): Zero values are stored in Calibration Memory when Calibration mode is on, but separate zero values can be stored in a temporary memory when Calibration mode is off. The temporary values are always replaced with the values stored in Calibration Memory when a power-up or reset occurs with Calibration mode off.

INITIALIZATION

CAUTION

Interruption of input power could affect Calibration Memory entries when the multimeter is in Calibration mode. Do not cycle input power to the multimeter when Calibration mode is activated. If power is ON, verify that the AVG/(CAL) annunciator is not flashing before cycling power to OFF. From the remote, Calibration mode status can be verified with the G5 command (response of 0 = mode off, response of 1 = mode on). If power is OFF, verify that the rear panel Calibration switch is off before cycling power to ON.

Both the 8505A and the 8506A assume the same configuration at power up as that described for 8502A, with the following exceptions:

1. The Average mode is disabled (O0).
2. Calibration Memory factors are retained at all times. These factors include zero corrections for each range in dc volts and ohms functions, gain corrections for each range in each function, and the calibration date (or instrument identification) number.
3. External Reference at power up or reset is used as temporary storage for the multimeter software version number. The GNR command can then be used to recall this number. Any use of the X command subsequent to power-up or reset replaces this number with the value applied at the external reference inputs.
4. Zero mode is enabled with the zero values stored in Calibration Memory.

HIGH SPEED MODE

Selection of the High Speed mode sets the following conditions:

1. The "!" command both enters the High Speed mode and triggers a reading.
2. Use of any character (or bit pattern) other than "?" causes the multimeter to exit the High Speed mode. Use of "*" causes the multimeter to both exit the High Speed mode and perform a normal reset.
3. Selection of High Speed mode specifies the binary output format. Any previously selected output format is restored once High Speed mode is exited.
4. The multimeter front panel display is blank while High Speed mode is on. The previously selected display mode is restored once High Speed mode is exited.

Table 2A-2. Programming Instructions (8505A, 8506A) (cont)

5. High Speed mode specifies asynchronous, single trigger mode (T2). The previously selected trigger mode is restored once High Speed mode is exited.

The high speed reading mode ("!") cannot be used for any ac volts function (normal, enhanced, or high accuracy) with the 8506A.

Voltage and Current Reading in "!"

The following scale factors are used:

FUNCTION	UNITS	RANGE				
		0	1	2	3	4
DC Volts (V)	V	1/100*	1/10*	1	64/10*	64
DC Amps (I)	mA	-1/80*	-1/10*	-8/10*	-64/10*	-512*
AC Volts (8505A only)	V	n/a	1/8	1	8	64
AC Amps (8505A only)	mA	1/64	1/8	1	8	64
*Differs from 8502A						

FUNCTION COMMAND CHARACTERS

The 8505A uses the same function command characters as those listed. The "C" command (dc coupled ac volts) can only be used when the True-RMS Converter (Option -09A) is installed. When an 8505A function is changed, the multimeter is configured as follows:

1. If the same function is re-selected, the multimeter assumes autoranging and retains all other existing modes and stored values.
2. If a new function is selected, the following configuration is set:
    a. Autoranging (R) is set.
    b. The existing trigger mode, sample, and filter are retained. However, if Average mode was previously on, it is turned off, sample is set to S7 and filter is set to F0.
    c. Offset, External Reference, Scaling, Limits, and Peaks are turned off (P0, X0, U0 respectively), with all respective values retained.
    d. Zero mode is set off if a function other than dc volts (V) or ohms (Z) is selected. If dc volts (V) or ohms (Z) is selected, the zero mode state (on or off) is restored to that in effect the last time either function was selected. Zero mode is always set on when a power-up or reset occurs. Values stored in temporary memory are retained and are defined as those loaded from Calibration Memory at the last power-up or reset, or subsequent values stored with Calibration mode off.
    e. Calibration mode is on or off (as determined by the Calibration Switch setting) and gain correction factors are enabled (M0).

When an 8506A function is changed, the multimeter assumes a configuration defined by the variety of both old and new functions. One variety includes dc volts (V), ohms (Z), and dc amps (I). The second variety includes all ac volts functions (VA, VA1, VA2, C, C1, and C2). Four types of configuration change are therefore possible. Each of these changes resembles that detailed above for the 8505A, with the following exceptions:

1. Initial function was V, Z, or I — New function is V, Z, or I:

   The 8505A configuration is used.

2. Initial function was V, Z, or I — New function is ac or ac+dc volts:
    a. Filter mode off (F0) is set.
    b. No sample setting is allowed.
    c. Zero mode is off.

3. Initial function was ac or ac+dc volts — New function is V, Z, or I:
    a. Filter mode on (F) or off (F0) is retained.
    b. Sample S7 is set.

4. Initial function was ac volts — New function is ac volts:
    a. If the initial and new functions are both ac volts (or both ac+dc volts), manual ranging mode is retained at the same range, or autoranging is retained (starting at the same range).
    b. If the change is between an ac volts function (VA, VA1, VA2) and an ac+dc volts function (C, C1, C2), autoranging is automatically enabled.
    c. For all types of change (ac to ac, ac+dc to ac, ac to ac+dc, or ac+dc to ac+dc), Averaging mode (extended resolution) and all other modes and values are retained. No sample change is allowed in any 8506A ac volts function.

The following commands are used when initially selecting an 8506A ac volts function:

1. V A : V AC Normal
2. V A 1 : V AC Enhanced
3. V A 2 : V AC High Accuracy
4. C : V AC Normal (DC Coupled)
5. C 1 : V AC Enhanced (DC Coupled)
6. C 2 : V AC High Accuracy (DC Coupled)

NOTE

AC volts function commands used with the 8502A/AT are compatible with the 8506A. However, the six function commands mentioned above allow for faster, direct entry into the desired 8506A ac volts mode.

If the 8506A is already in an ac volts function, an abbreviated command can be used when selecting either of the other two ac volts functions. When selecting between ac or dc coupling for ac volts, the full command string mentioned above must be used. The abbreviated commands are as follows:

1. S 0 : V AC Normal
2. S 1 : V AC Enhanced
3. S 2 : V AC High Accuracy

Table 2A-2. Programming Instructions (8505A, 8506A) (cont)

RANGE COMMAND CHARACTERS

The nine range commands used with the 8505A or 8506A specify the full scale values by function as follows:

	DC VOLTS (V)	AC VOLTS 8505A	AC VOLTS 8506A	DC AMPS (I)	AC AMPS (IA) 8505A	OHMS (Z or Z1)
R	Auto	Auto	Auto	Auto	Auto	Auto
R 0	200 mV	Auto	125 mV	250 μA	312.5 μA	20 ohms
R 1	2V	2.5V	400 mV	2.0 mA	2.5 mA	200 ohms
R 2	20V	20V	1.25V	16 mA	20 mA	2 kohms
R 3	128V	160V	4V	128 mA	160 mA	20 kohms
R 4	1200V	1000V	12.5V	1.28A	1.28A	200 kohms
R 5	Auto	Auto	40V	Auto	Auto	4.1 Mohms
R 6	Auto	Auto	125V	Auto	Auto	35 Mohms
R 7	Auto	Auto	600V	Auto	Auto	265 Mohms

Resolution available for remote readings is as follows:

FUNCTION	RANGE	ASCII DIGITS* STANDARD MODE	ASCII DIGITS* AVERAGING OR CALIBRATION MODE
DC Volts (V)	100 mV (R0)	6½ (5½)	6½
	1V (R1)	6½	6½
	10V (R2)	6½	7½
	100V (R3)	6½	6½
	1000V (R4)	6½	6½
Ohms (Z)	10 ohms (R0)	6½	6½
	100 ohms (R1)	6½	6½
	1 kohm (R2)	6½	6½
	10 kohms (R3)	6½	6½
	100 kohms (R4)	6½	6½
	1 Mohm (R5)	6½	6½
	10 Mohms (R6)	6½	6½
	100 Mohms (R7)	6½	6½
DC Amps (I)	100 μA (R0)	6½ (5½)	6½
	1 mA (R1)	6½	6½
	10 mA (R2)	6½	6½
	100 mA (R3)	6½	6½
	1A (R4)	6½	6½
AC Amps (8505A only)	100 μA (R0)	5½	5½
	1 mA (R1)	6½	6½
	10 mA (R2)	6½	6½
	100 mA (R3)	6½	6½
	1A (R4)	6½	6½
AC Volts (VA) or AC + DC (C) (8505A only)	1V (R1)	6½	6½
	10V (R2)	6½	6½
	100V (R3)	6½	6½
	1000V (R4)	6½	6½

Table 2A-2. Programming Instructions (8505A, 8506A) (cont)

FUNCTION	RANGE	ASCII DIGITS*	
		STANDARD MODE	AVERAGING OR CALIBRATION MODE
AC Volts (VA, VA1, VA2) or AC + DC (C, C1, C2) (8506A only)	100 mV (R0)	6½ (5½)	6½
	300 mV (R1)	6½ (5½)	6½
	1V (R2)	6½	6½
	3V (R3)	6½	6½
	10V (R4)	6½	6½
	30V (R5)	6½	6½
	100V (R6)	6½	6½
	500V (R7)	6½	6½

*Resolution in binary mode is generally the same as in ASCII mode. Differing resolution in binary mode is shown in parentheses.

SAMPLES PER READING COMMAND CHARACTERS

Use of the sample commands is modified as follows:

1. With the 8505A, samples-per reading can be set with command S, followed by one or two digits (0-17). Digits greater than 17 cause a command string error (08). The H command can still be used, but the multimeter recognizes only one following digit (0-9, corresponding to S8 through S17 respectively).
2. With the 8506A (dc volts, ohms, dc amps only), samples-per-reading can be commanded in the manner described above.
3. With the 8506A set for ac volts, no sample changes are allowed. Therefore, commands S0 through S17 (or H0 through H9) cannot be used for sample settings when the 8506A is set for ac volts normal, enhanced, or high accuracy. However, the first three commands (S0, S1, S2) are used when commanding ac volts functions as follows:
   a. S0 commands ac volts normal. When initially commanding an ac volts function, only VA (for ac coupling) or C (for dc coupling) need be used. When the multimeter is already set for either of the other two ac volts functions, ac volts normal can be selected by using S0 only.
   b. S1 commands ac volts enhanced. When initially commanding an ac volts function, VA1 (for ac coupling) or C1 (for dc coupling) must be used. when the multimeter is already set for either of the other two ac volts functions, ac volts enhanced can be selected by using S1 only.
   c. S2 commands ac volts high accuracy. When initially commanding an ac volts function, VA2 (for ac coupling) or C2 (for dc coupling) must be used. when the multimeter is already set for either of the other two ac volts functions, ac volts high accuracy can be selected by using S2 only.

FILTER COMMAND CHARACTERS

Any filter command is acceptable for the 8505A or the 8506A (in V, Z, or I only). However, when Average mode is enabled, filter F is initially selected and can only be changed to F2 or re-selected. Any other filter selection (F0, F1, or F3), while accepted by the multimeter, sets the Average mode disabled and the sample at S7.

When the 8506A is in an ac volts function, only filter F0 (set at new function selection) or F (subsequently selected for inputs less than 40 Hz) is allowed.

TRIGGER COMMAND CHARACTERS

When the multimeter (8505A or 8506A) is in a continuous trigger mode (T or T1), the reset command (*) causes a normal multimeter reset. All other commands are buffered and examined only when the halt command (%) is sent.

Table 2A-2. Programming Instructions (8505A, 8506A) (cont)

With any trigger mode, no command string is examined until the existing reading or recalled value is returned. Any reading or recall value commanded (but not yet returned) can be discarded by sending the halt (%) command. If a continuous trigger mode (T or T1) is in effect when (%) is sent, the multimeter configuration is changed to single trigger mode (T0 or T2), and any buffered commands (with a terminating character) are executed.

AVERAGING COMMAND CHARACTERS

With the 8505A (all functions) and the 8506A (dc volts, ohms, dc amps only), the "0" character is used to command a preset sample and filter combination for each function and range to optimize accuracy and stability. Averaging also provides an extra digit of resolution in several ranges (as defined under RANGE COMMAND CHARACTERS). The following commands are available:

1. 0 : Averaging mode enabled.
2. O 0 : Average mode disabled.

Enabling of Average mode in the situations defined above sets the multimeter to sample S10 and filter F. With Average mode enabled, samples S11-S17 or filter F2 can also be selected. Disabling of Average mode changes the sample and filter again and occurs under any of the following circumstances:

1. Command O0 is sent. Averaging mode is disabled. The sample is set to S7 and the filter is set to F0.
2. The function is changed. The sample is set to S7 and the filter is set to F0. If an ac volts function is initially selected with the 8506A, only filter F0 is set. If a change is made between 8506A ac volts functions (VA, VA1, VA2, C, C1, C2), Averaging (extended resolution) is retained.
3. A sample or filter not allowed in Average mode is commanded. If S0-S9 is commanded, Average mode is disabled, the new sample setting is accepted and the filter is set to F0. If a filter other than F or F2 is selected, Average mode is disabled, the new filter is accepted and the sample is set to S7.

With the 8506A set for any of the ac volts functions, Average mode is not available. However, the 0 or O0 command can still be used to enable or disable extended resolution (as defined under RANGE COMMAND CHARACTERS). In this situation, only the sample and filter restrictions defined by the 8506A ac volts functions are applicable. No sample change can be made. Only filter F0 or F (for input signals less than 40 Hz) can be selected. If a sample change is attempted or an unallowed filter is commanded, a momentary error is set and extended resolution is retained. Extended resolution in 8506A ac volts functions is disabled if the O0 command is sent. If a change is made between ac volts functions, extended resolution is retained with the existing filter mode. If dc volts, ohms, or dc amps is selected, extended resolution (Average mode) is disabled, the filter is not changed, and the sample is set to S7.

Whenever the "0" character is used (8505A or 8506A - any function), the multimeter responds with the following output format:

BINARY OUTPUT FORMAT

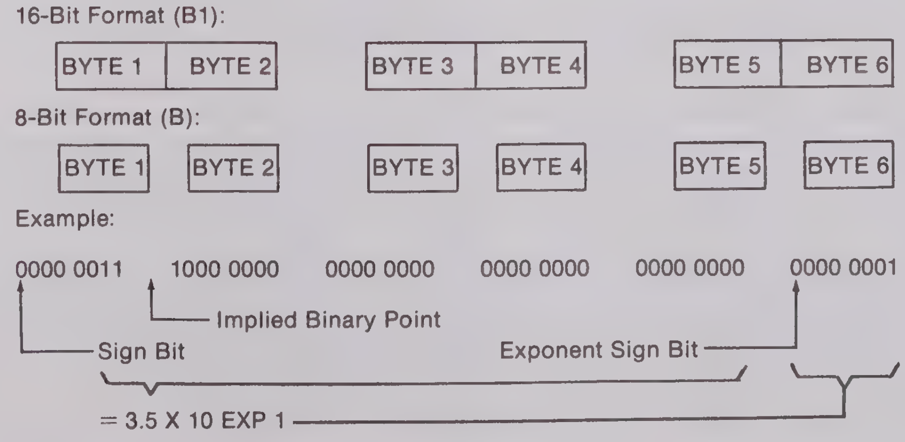
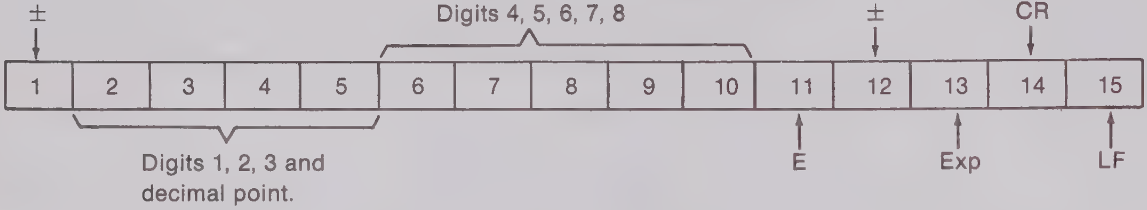


Table 2A-2. Programming Instructions (8505A, 8506A) (cont)

ASCII OUTPUT FORMAT



Digit 8 is used only on the 10V dc range to yield 7½ digit resolution. On all other ranges and functions, 6½ digit resolution is used and digit 8 is set to 0.

OFFSET COMMAND CHARACTERS

When storing the previous reading as an offset, both the 8505A and the 8506A use the displayed value in the same manner as does the 8502A.

LIMITS AND PEAKS COMMAND CHARACTERS

When Limits testing is enabled (U), an error is identified by either of the following responses:

1. The standard error response message (programmed with the K3 command) is normally returned.
2. If no such standard error response message has been programmed since the last power-up or reset, a "2" is returned to identify an error occurring during limits testing.

CONTROL COMMAND CHARACTERS

ASCII Data Output Format

Digit 7 is used with the 8505A and 8506A whenever 6½ digits of resolution are available. If 5½ digits are available, digit 7 is not needed and is consequently set to 0.

CALIBRATION CONSTANT

The Calibration Memory is a standard feature with the 8505A and the 8506A. Therefore, the "M" and "M0" commands may be used at any time to inhibit or enable Calibration Memory gain correction factors. Zero correction values, although applied in dc volts (V) or ohms (Z), can be controlled when the multimeter is in any function. The following commands are available:

1. M1 : inhibit zero correction values.
2. M2 : enable zero correction values.

Calibration Memory allows for software calibration of all functions and is fully described in Appendix 7B. Although software calibration procedures are not discussed here, the following considerations must be made if Calibration mode is activated.

Calibration gain correction factors are applied to the reading when Calibration mode is on or off and the M command (inhibit Calibration Memory factors) has not been sent. Resolution available for each range and function is the same for Calibration mode as for Averaging mode (refer to RANGE COMMAND CHARACTERS). Calibration mode can be enabled or disabled (only when the multimeter is in local control) by positioning of the rear panel Calibration Switch.

Zero correction values are applied in dc volts (V) or ohms (Z) whenever the M2 command is in effect. The zero mode is always turned on at power-up or reset. The actual zero values are those stored in Calibration Memory (entered with the multimeter in Calibration mode) or separate values entered into temporary memory (when the multimeter is not in Calibration mode). Temporary zero memory is always loaded with Calibration Memory zero values when a power-up or reset occurs.

Table 2A-2. Programming Instructions (8505A, 8506A) (cont)

MEMORY COMMAND CHARACTERS

STORE

Commands K0 (store dc volts zero) and K1 (store ohms zero) can be used with either the 8505A or the 8506A. However, the zero value is stored in the following new fashion:

1. If Calibration mode is on (G5 response = 1), any zero value entered with the K0 or K1 command is stored directly in the Calibration Memory and retained until a new value is stored during Calibration mode on. Software calibration uses this procedure and is fully described in Appendix 7B.
2. If Calibration mode is off (G5 response = 0), any zero value entered with the K0 or K1 command is stored in a separate (temporary) memory. This value does not affect any value already stored in Calibration Memory. The temporary value is retained and applied to subsequent readings until a power-up or reset condition occurs when the multimeter is still in the Calibration mode off condition. If power-up or reset occurs when the Calibration mode is off, the temporary values are updated with those stored in Calibration Memory.
3. Whenever the K0 or K1 command is used (Calibration mode on or off), a separate zero value can be stored for each range.
    a. If Calibration mode is on, the zero value is stored for the range selected without affecting the value for any other range.
    b. If Calibration mode is off, any zero value stored is applied to the existing range and all higher ranges in the same function. Therefore, separate values for each range can be entered by using K0 (or K1) sequentially for each range (from lowest to highest).

The following additional store commands are available for the 8505A or the 8506A:

1. KNG : Keep gain correction on this range. This command is used when storing calibration gain correction factors with Calibration mode on. Software Calibration (Appendix 7B) deals with this procedure in detail.
2. KND : Keep the following six digits as the calibration date or the multimeter identification. Any value totaling 999999 or less can be entered (with Calibration mode on). Zeros are not suppressed if less than six digits are entered. The full procedure is defined in Software Calibration (Appendix 7B).
3. K3 : Keep the error response message. This command allows the operator to specify the response for an error condition. These characters (instead of the actual reading) are then automatically returned whenever an error condition occurs. For example, the word ERROR or an obviously illegal response value (such as 1E20) can be programmed as the error response message. The desired response must be reprogrammed after a power-up or reset condition occurs. The multimeter returns 0 as the error message if no other message has been programmed. The actual error can only be identified as the first and second characters of the G1 (Get Status) response. The following rules must be followed when making the K3 entry:
    a. A maximum of any 15 characters (excepting immediate and termination characters) can be programmed following the K3 command. Spaces can be used as part of the 15 character total. Characters in excess of 15 are ignored by the multimeter and do not cause an error condition.
    b. Nulls are discarded and not stored. Nulls are not counted for the 15 character limit.
    c. Any immediate character (including termination characters) terminates and executes the string normally.
    d. The $ command is an immediate character only when used with the Bit Serial Interface (Option -06). With the IEEE-488 Interface (Option -05) or Parallel Interface (Option -07), $ is not an immediate character and can be used as part of the K3 command string.

Table 2A-2. Programming Instructions (8505A, 8506A) (cont)

e. The # command is an immediate character only when used with the Bit Serial Interface (Option -06) or the Parallel Interface (Option -07). With the IEEE-488 Interface (Option -05), the # command is not an immediate character and can be used as part of the K3 command string.

4. K 4 G 1 : Clear all of Calibration Memory. If it is necessary to clear all calibration factors (as in a check sum error 25 condition or prior to hardware calibration of all functions), the K4G1 command string can be used. Depending on the number of entries being cleared, several seconds may be necessary to complete this operation. Completion of this comprehensive clearing operation is verified by return of the status response.

CAUTION

If any interrupting command is sent immediately after K4 (and before G1), the comprehensive clearing operation may be interrupted prior to completion. A check sum (error 25) condition would then be set. Do not send any interrupting command (immediate characters, reset, etc.) between K4 and G1.

5. K 2 : Store previous reading as scaling factor.

RECALL

Recall DC Zero (G0)

The G0 command (recall dc zero and send on next trigger) operates in the following fashion for either the 8505A or the 8506A:

1. The multimeter can store separate dc zero values for each range. If G0 is used when dc volts function is selected, the dc zero recalled is the value for the range selected. If G0 is used when any other function is selected, the dc zero recalled is the value for the 100 mV range only.

2. The multimeter can also store zero values in two separate memories. The recalled dc zero value depends on the state of Calibration mode at the time G0 is used. When Calibration mode is on, zero values recalled are those stored in Calibration Memory. When Calibration mode is off, zero values recalled are those stored in a separate, temporary memory. Also note that any zero values stored in temporary memory (with Calibration mode off) are replaced by Calibration Memory zero values when power-up or reset occurs.

Recall Status (G1)

The first two digits of the G1 response (error codes) are identified in two steps. The first step involves a user-programmed error message that is returned whenever an error condition has been generated. This message is stored in an error response buffer and serves only as a "flag" that an error exists. It does not identify the error. An error message is programmed with the K3 command, followed by any combination of up to 15 characters. For example, an obviously illegal multimeter response of 1E20 could be specified as the error message. If no such special message has been programmed, a returned "0" is used. In any case, this message alone is returned whenever an error condition has been generated and a response from the multimeter has been commanded. The error message may be returned repeatedly. This depends on the type of error condition generated (momentary or latching) and subsequent corrective actions. The following rules apply:

1. Each momentary error condition generates only one error message.

2. A latching error condition, if not corrected, generates repeated errors. Therefore, the error message is returned for each attempted reading.

For the second step, the G1 (get status) command must be sent. The first and second characters of the status response then identify the error condition by number. This two-digit error code is stored in a separate error condition buffer and is subject to the following rules:

1. A single two-digit error code can occupy the error buffer.

2. If a multiple error condition exists, only the last error to have been generated is stored in the error buffer.

Table 2A-2. Programming Instructions (8505A, 8506A) (cont)

3. The error buffer is cleared (set to 00) when either of the following actions occurs:

   a. The G1 command is sent. The error is returned in the status response, and the buffer is reset to 00. If the error still exists, a new reading must be triggered to reload the error buffer (and return the error message). If another G1 command is sent before a new reading is triggered, no error (00) is identified in the response.

   b. A valid reading is triggered. The reading is returned and the buffer is reset to 00.

The multimeter employs both momentary and latching errors. A momentary error in the buffer can be cleared by sending the G1 command or by triggering a valid reading. If the momentary error does not reoccur, further multimeter operation is not impeded. A latching error, if not corrected, does impede further multimeter operation by generating another error (and returning the error message) each time a reading is triggered. Clearing the error buffer by sending G1 does not affect this impediment. Latching errors include 12, 13, 14, 15, 19, and 24.

A momentary error condition is illustrated in the following example. Assume that 1V dc is applied to a multimeter configured for dc volts. The following sequence of commands is sent: VR0? KG1? R1? The first command (VR0?) triggers an overrange, causing the error message to be returned. The second command (KG1?) attempts to store this overrange as an offset, loads momentary error 11 into the error buffer, and returns 11 (the most recent error to be generated) in the status response. The third command (R1?) triggers and returns a valid reading and resets the error buffer to 00.

A latching error condition is encountered in the following example. Assume that the multimeter is configured for dc volts (V), but not dc current measurement (I), and 1V dc is applied to the inputs. The following sequence of commands is sent: IR1? G1? ? V? The first command (IR1?) triggers an invalid reading, loads the error buffer with latching error 19, and causes the error message to be returned. The second command (G1?) returns 19 as the first two characters of the status response and resets the error buffer to 00. The third command (?) triggers another invalid reading, loads the error buffer with 19 again, and returns the error message. The fourth command (V?) is valid. Therefore, the actual reading is returned, and the error buffer is reset to 00.

NOTE

Latching errors are enabled at all times (Calibration mode on or off) when remote operation is in use. However, latching errors can be disabled locally (with Calibration mode on). This procedure is intended for use during troubleshooting only. Do not attempt to disable latching errors at any other time.

The following additional error conditions can occupy the error buffer for either the 8505A or the 8506A:

1. 23 : The Calibration Memory is faulty or not installed.

2. 24 : Illegal module configuration.
   This error occurs at power-up or reset. It may mean that a Calibration Memory module is installed. The 8505A and 8506A do not use a separate module for calibration memory entries (calibration memory is a standard part of the Controller module). If a Calibration Memory module is installed, it must be removed. Also, error 24 may mean that the wrong ac converter configuration is installed. The 8505A uses either the -01 Option or the -09A Option (not both). The 8506A uses only the Thermal True-RMS Converter. If an illegal ac converter is installed, it must be removed. If the illegal configuration is not corrected, the error buffer is cleared (G1 sent), and a valid function is subsequently selected, the illegal module configuration does not interrupt further multimeter operation. However, if both ac converters (-01 and -09A) are installed in the 8505A, the ac volts command (VA or C) causes selection of the -09A converter only.

3. 25 : The Calibration Memory check sum is wrong.
   This error condition may occur when applying power, when storing into Calibration Memory, or when recalling a Calibration Memory entry. It may be caused by an inadvertent cycling of power when the multimeter is in the Calibration mode. Ensure that Calibration mode is off, then try re-initializing power to the multimeter. If error 25 remains, it may be necessary to first clear, and then re-enter, all correction factors, zero values, and the calibration date (or instrument identification number). If error 25 recurs during the clearing procedure or during any subsequent programming attempt, the Calibration Memory may be faulty.

Table 2A-2. Programming Instructions (8505A, 8506A) (cont)

4. 27 : Ohms input problem
   Error 27 can occur under any of the following circumstances:
   a. At least one ohms input connection is open.
   b. An input polarity reversal has been made in four-terminal connections.
   c. An input protection fuse is bad. For input connections at either the front panel terminals or through the rear input connector, any of the input fuses on the Front/Rear Switch PCB could be bad. Either the front or rear current/ohms fuse could also cause this error condition.

The third character of the G 1 (recall status) response is modified when used with the 8506A in an ac volts function. The third character (range codes) is then defined as follows:

0	100 mV	3	3V	6	100V
1	300 mV	4	10V	7	500V
2	1V	5	30V		

The fifth character (function codes) of the response to G1 is modified for the 8506A. Since ac current cannot be measured with the 8506A, the fifth character cannot be defined as "3". Further, if the fifth character is a "1" (ac volts) or a "5" (dc coupled ac volts), the specific ac volts function must also be identified. Since sample codes are not used in 8506A ac volts functions, the fourth character (Sample) is utilized to define whether normal mode (fourth character = 0), enhanced mode (1), or high accuracy mode (2) is selected.

Additional Recall Commands

The following additional recall commands are available with either the 8505A or the 8506A:

1. G 2 : Recall multimeter configuration and send on next trigger. This recall command is useful in determining the multimeter type and identification number, verifying the installed modules prior to a performance test or calibration, and identifying the cause of an error 24 (illegal module configuration). A 22-character response identifies the multimeter and its hardware configuration as follows:
   a. Characters 1-5: the model number (e.g. 8506A)
   b. Characters 6-8: a special number (or blank)
   c. Character 9: a colon (:)
   d. Characters 10-22: 13 characters identifying the loaded modules.

      D : DC Signal Conditioner
      F : Active Filter
      C : A/D Converter
      1 : Averaging AC Converter (Option -01)
      2 : Ohms Converter (Option -02A)
      3 : Current Converter (Option -03)
      4 : Not used (always = -)
      5 : IEEE-488 Interface (Option -05)
      6 : Bit Serial Interface (Option -06)
      7 : Parallel Interface (OPtion -07)
      8 : Isolator
      9 : True-RMS Converter (Option -09A)
      A : Thermal True-RMS Converter

Table 2A-2. Programming Instructions (8505A, 8506A) (cont)

Any module not installed is noted with a (-) in the response. For the 8505A, a response of DFC12----78-- would signify a standard dc volts configuration (DFC) with the Isolator (8) and options for averaging ac (1), ohms (2), and parallel interfacing (7). For the 8506A, a response of DFC--3-5--8-A would identify a standard dc volts (DFC) with the Isolator (8) and thermal true-rms volts (A) configuration with options for dc current (3), and IEEE-488 interfacing (5). Modules allowed in either instrument are defined as follows:

POSSIBLE CONFIGURATION	**ALLOWED CONFIGURATION (S = standard, O = optional, N = not allowed, - = not used)**	
	8505A	**8506A**
D	S	S
F	S	S
C	S	S
1	O (1)	N
2	O	O (2)
3	O (1)	O (2)
4	-	-
5	O (3)	O (3)
6	O (3)	O (3)
7	O (3)	9 (3)
8	S (3)	S (3)
9	O (1)	B
A	N	S

NOTES:

(1) 8505A AC Volts (VA) uses either Averaging (Option -01) or True-RMS (Option -09A) converter. 8505A AC Amps (IA) uses Current Converter (Option -03) and either ac converter. If both ac converters are installed with ac volts or ac amps selected, the True-RMS converter (Option -09A) is used.

(2) 8506A can use either the Ohms Converter (Option -01A) or the Current Converter (Option -03) — not both.

(3) 8505A and 8506A: only one interface (Option -05, -06, or -07) can be installed at one time.

2. G3: recall front/rear input selector status on next trigger. Response is as follows:

   0 (rear inputs)
   1 (front inputs)

3. G 4 : recall the calibration date (or instrument identifying) number. Response includes six digits with no leading zero suppression. If the Calibration Memory is not installed, the response is 0 0 0 0 0 0, and no error is generated.

4. G 5 : recall Calibration mode status. A returned 0 identifies Calibration mode off, and a returned 1 identifies Calibration mode on.

5. G 6 : recall Ohms zero value and send on next trigger. If G6 is sent when the Ohms function is selected, the zero value for the range selected is returned. If any other function is selected when G6 is sent, the zero value for the 10 ohm range (R0) is returned.

If any unspecified G command is attempted (such as G7), the multimeter assumes that G (recall previous reading and send on next trigger) has been sent.

Section 3
Theory of Operation

3-1. INTRODUCTION

3-2. This section describes the theory of operation for the mainframe, which includes the modules necessary for dc volts and dc ratio measurements. Block Diagram Description gives an overview of the operation of the multimeter and an explanation of its bus structure. This description is followed by Circuit Analysis, which gives a more detailed description of the circuitry. Optional modules are described in Section 6.

3-3. BLOCK DIAGRAM DESCRIPTION

3-4. Bus Structure

3-5. The multimeter is constructed with a bus architecture similar to that of a computer. Figure 3-1 is an overall block diagram of the instrument with optional modules drawn in dashed lines. Figure 3-2 is a block diagram illustrating signal flow. A microprocessor-based Controller module controls information flow on the three buses. The Controller sets up each of the analog modules for a measurement by addressing the modules as memory locations. An unguarded digital interbus is used to connect the Controller to the front panel and to digital option modules.

3-6. The unguarded digital bus consists of the following lines:

1. Address/Control (IC)
2. Bidirectional data (ID)
3. Real time (RT)
4. Handshake (EXTINT, ACK, INA)
5. Input/Output (SCAN ADV, EXT TRIG, FRONT/REAR SENSE)
6. Power supply

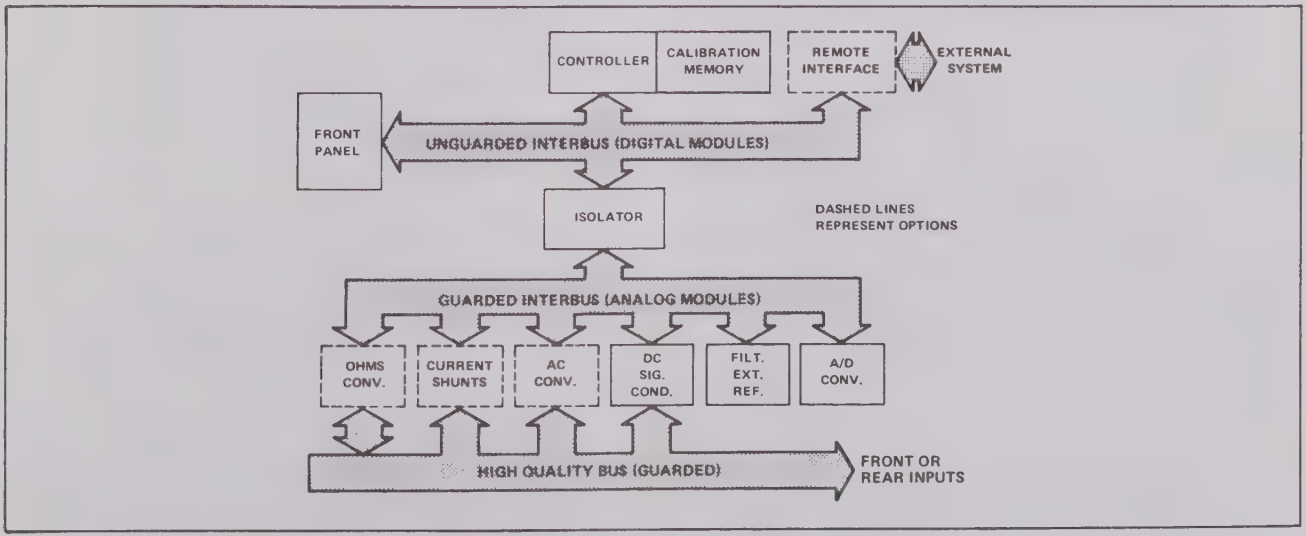

CONTROLLER
CALIBRATION MEMORY
REMOTE INTERFACE
EXTERNAL SYSTEM
FRONT PANEL
UNGUARDED INTERBUS (DIGITAL MODULES)
ISOLATOR
DASHED LINES REPRESENT OPTIONS
GUARDED INTERBUS (ANALOG MODULES)
OHMS CONV.
CURRENT SHUNTS
AC CONV.
DC SIG. COND.
FILT. EXT. REF.
A/D CONV.
HIGH QUALITY BUS (GUARDED)
FRONT OR REAR INPUTS

Figure 3-1. 8505A Block Diagram

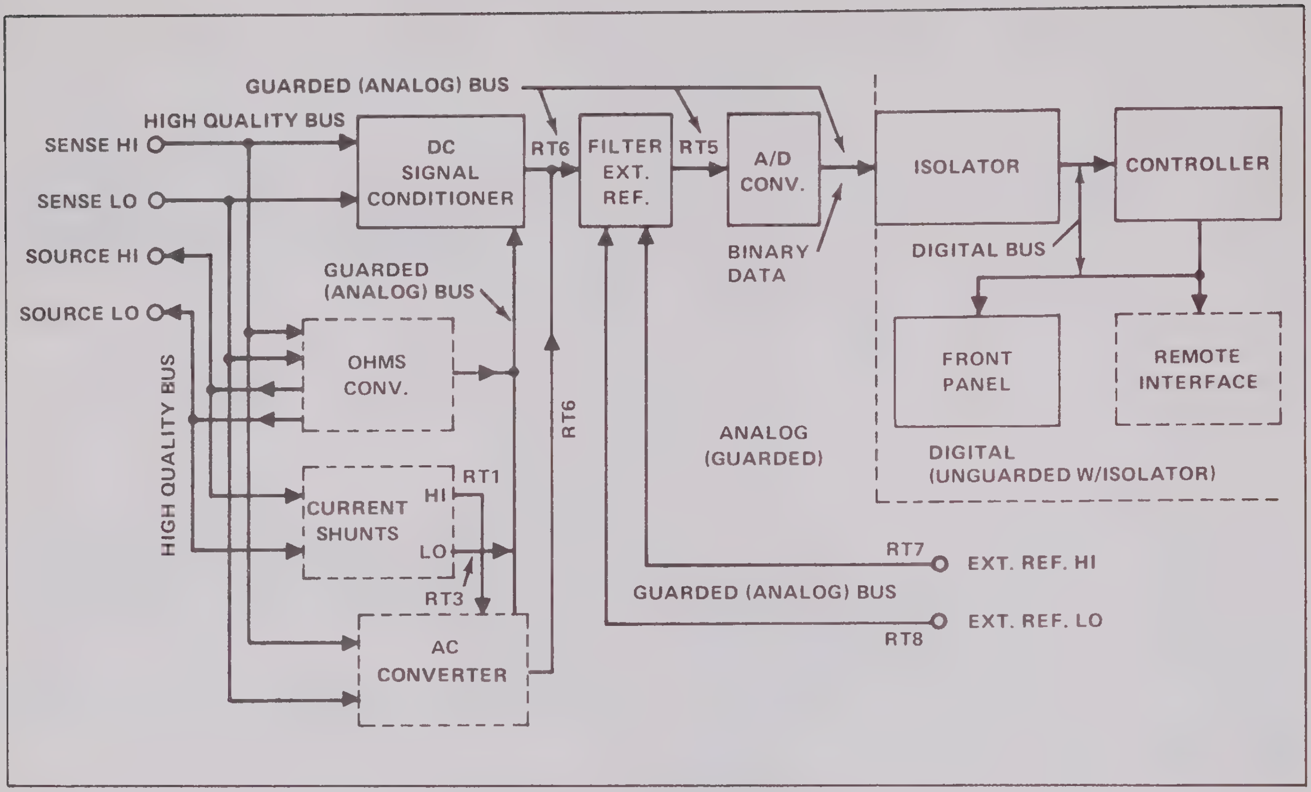

GUARDED (ANALOG) BUS
HIGH QUALITY BUS
SENSE HI
SENSE LO
SOURCE HI
SOURCE LO
DC SIGNAL CONDITIONER
RT6
FILTER EXT. REF.
RT5
A/D CONV.
BINARY DATA
ISOLATOR
CONTROLLER
DIGITAL BUS
FRONT PANEL
REMOTE INTERFACE
GUARDED (ANALOG) BUS
OHMS CONV.
RT6
ANALOG (GUARDED)
DIGITAL (UNGUARDED W/ISOLATOR)
HIGH QUALITY BUS
RT1
HI
CURRENT SHUNTS
LO
RT3
AC CONVERTER
RT7
EXT. REF. HI
GUARDED (ANALOG) BUS
EXT. REF. LO
RT8

Figure 3-2. Analog Signal Flow

3-7. The guarded bus connects the Controller to the analog modules through the Isolator module. The guarded bus consists of the following lines:

1. Address/Control (IC)
2. Bidirectional data (ID)
3. Real time
4. Handshake (ACK)
5. Power Supply

3-8. The address, handshake, and data lines of the two buses serve the same functions. The real time and power supply lines may have differing functions. For example, the RT lines in the unguarded bus are unused except for RT5 (frequency reference). The RT lines in the guarded bus form an analog bus which carries all the conditioned and converted analog signals between the analog modules. The external reference input lines are part of the analog bus (RT7 and RT8). Logic supply lines (Vcc and Vss) are –15V and –20V with respect to analog common. With the Isolator installed, Vcc and Vss are isolated from analog common.

3-9. The high quality bus consists of lines connecting the input switch (Sense HI and LO, Source HI and LO, Guard, Ohms Guard) to the signal conditioning and converting modules (ac converters, ohms converter, etc.). Ohms guard is only available through the rear inputs.

3-10. Controller

3-11. Under the direction of the software program, the controller addresses and sets up each of the modules necessary to perform a function. Two types of addresses are used: direct and indirect. An indirect address requires a previous direct address to set up the indirect address response logic. Data transfers are accomplished with a handshake between the address (IC) lines and the acknowledge (ACK) line. When the controller addresses a module, it places data on the data (ID) lines or receives data from the addressed module. The addressed module must respond with an ACK signal signifying that it is receiving or sending data.

3-12. The controller directs the R^2 A/D converter in taking a sample and receives the sample data from the converter. The controller stores range and function information for application to the sample data. Using the arithmetic capability of the microprocessor, the software processes the data to arrive at a binary twos complement number which represents the polarity and value of the measurement. This number is made available to an optional remote interface either as is or after further processing to ASCII code. The number is further processed by the controller for application to the front panel display in a seven-segment LED format.

3-13. The software program consists of two parallel processes. A background process (Figure 3-3) is responsible for interrupt driven activities such as updating the display digits and directing the A/D converter in taking a sample. The foreground process (Figure 3-4) is responsible for the measurement cycle including accumulating data from the background process and performing required calculations.

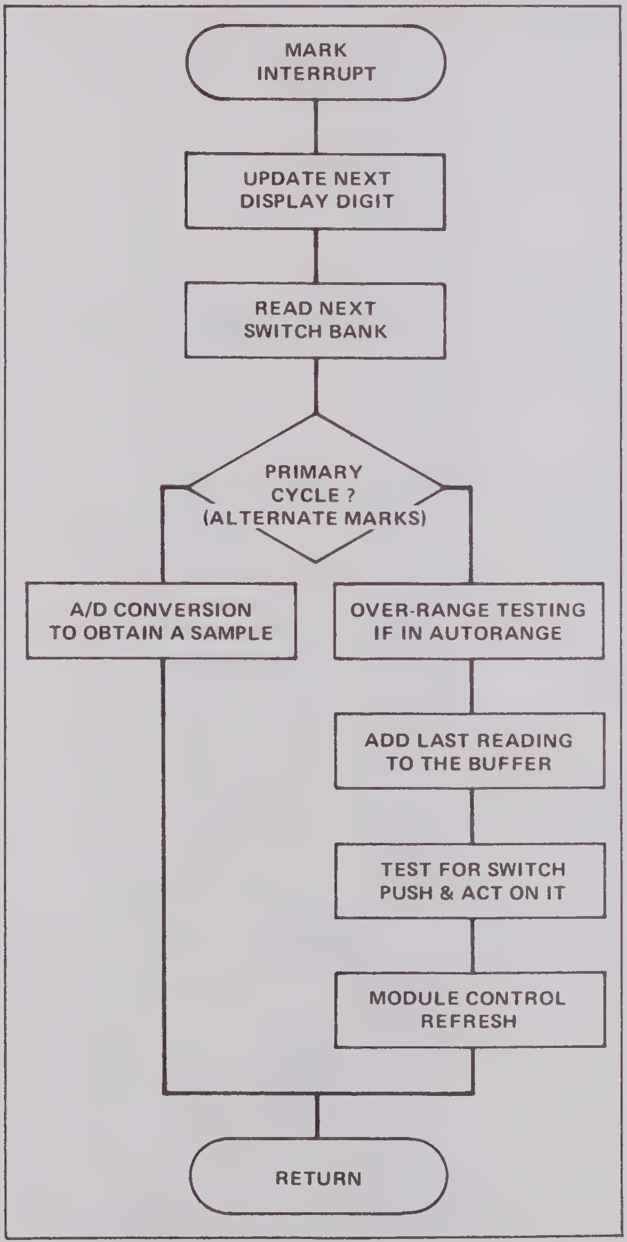

MARK INTERRUPT
UPDATE NEXT DISPLAY DIGIT
READ NEXT SWITCH BANK
PRIMARY CYCLE ? (ALTERNATE MARKS)
A/D CONVERSION TO OBTAIN A SAMPLE
OVER-RANGE TESTING IF IN AUTORANGE
ADD LAST READING TO THE BUFFER
TEST FOR SWITCH PUSH & ACT ON IT
MODULE CONTROL REFRESH
RETURN

Figure 3-3. Background Software Process

3-14. The controller is structured around the Intel 8080 microprocessor. Figure 3-5 is a block diagram of the controller module. Hardware control functions have been minimized by software design. Sequences of events are timed from two sources. Basic operations of the microprocessor are run from a 1.7 MHz clock. The other source is generated by shaped line frequency pulses, which are applied to a phase-locked loop. The phase-locked loop multiplies the line frequency by eight. This signal is used to generate mark interrupts which time the background process.

3-15. Memory for the multimeter consists of two ROMs for software and one RAM for variables. Data lines (DB0-DB7) are used for bidirectional data flow. Address lines (A0-A15) determine the source or destination for data and instructions. Modules in the multimeter system are memory mapped and are accessed through normal memory reference instructions.

3-16. Interrupts are used to divert the microprocessor from the main program to service other routines. Interrupts are synchronized to an appropriate time in the microprocessor cycle through interrupt control, where assigned priorities vector module identity data onto the data bus. Module identity data words direct the microprocessor to the memory location containing the next instruction. Two interrupts are internally generated: ACKINT and MARKINT (priorities one and six respectively). ACKINT is generated when an acknowledge signal is not returned. MARKINT is used to synchronize A/D samples and display digit updates to the line frequency.

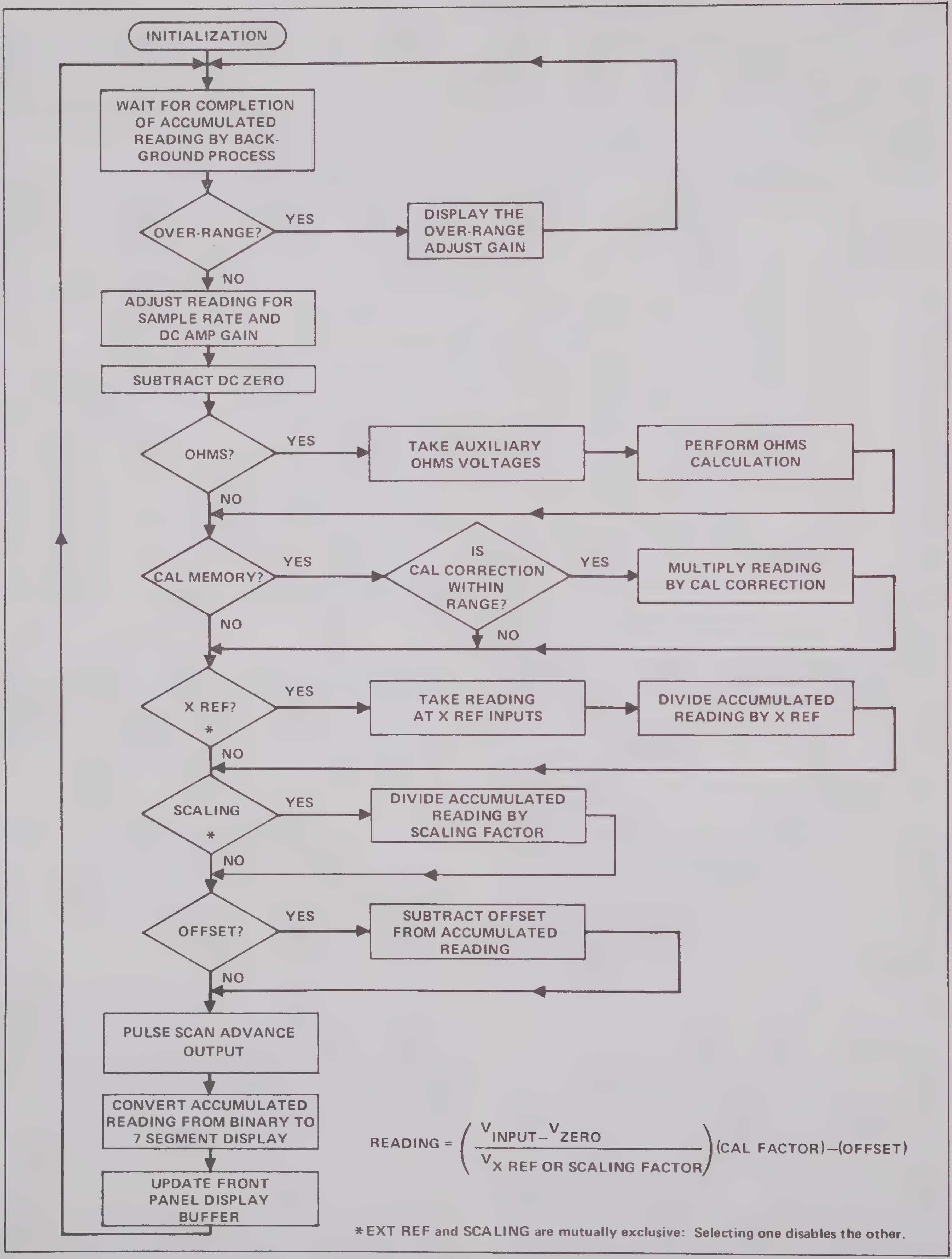
3-17. An interrupt may be externally requested by pulling the EXTINT line low. When the microprocessor is ready to accept the interrupt, the interrupt acknowledge (INA) signal is generated. The requesting module must respond with an ACK and a data bit (on ID1-ID3) which is used as a priority vector by interrupt control.

3-18. Software or hardware resets may occur. Software resets result from front panel requests or remote requests. Hardware resets are generated from the reset logic by monitoring line frequency on RT5. On power-up, or for line disturbances, the reset logic initializes the microprocessor and other logic. At power down, the reset signal prevents erroneous operation.

3-19. The control logic can be divided into two areas: control of the microprocessor and control of the external logic. The microprocessor control logic is used when the microprocessor enters and exits wait states. The external control logic is responsible for latching status information from the microprocessor at the beginning of each instruction cycle. The status information controls and synchronized the activities of the external logic.

3-20. Front Panel

3-21. The front panel serves as an interface between the operator and the controller. The display is multiplexed by the controller by means of addressing the front panel for each digit. One direct address, two indirect addresses, and


INITIALIZATION
WAIT FOR COMPLETION OF ACCUMULATED READING BY BACKGROUND PROCESS
OVER-RANGE?
YES
DISPLAY THE OVER-RANGE ADJUST GAIN
NO
ADJUST READING FOR SAMPLE RATE AND DC AMP GAIN
SUBTRACT DC ZERO
OHMS?
YES
TAKE AUXILIARY OHMS VOLTAGES
PERFORM OHMS CALCULATION
NO
CAL MEMORY?
YES
IS CAL CORRECTION WITHIN RANGE?
YES
MULTIPLY READING BY CAL CORRECTION
NO
NO
X REF? *
YES
TAKE READING AT X REF INPUTS
DIVIDE ACCUMULATED READING BY X REF
NO
SCALING *
YES
DIVIDE ACCUMULATED READING BY SCALING FACTOR
NO
OFFSET?
YES
SUBTRACT OFFSET FROM ACCUMULATED READING
NO
PULSE SCAN ADVANCE OUTPUT
CONVERT ACCUMULATED READING FROM BINARY TO 7 SEGMENT DISPLAY
UPDATE FRONT PANEL DISPLAY BUFFER

$$\text{READING} = \left(\frac{V_{\text{INPUT}} - V_{\text{ZERO}}}{V_{\text{X REF OR SCALING FACTOR}}}\right)(\text{CAL FACTOR}) - (\text{OFFSET})$$

*EXT REF and SCALING are mutually exclusive: Selecting one disables the other.

Figure 3-4. Foreground Software Process

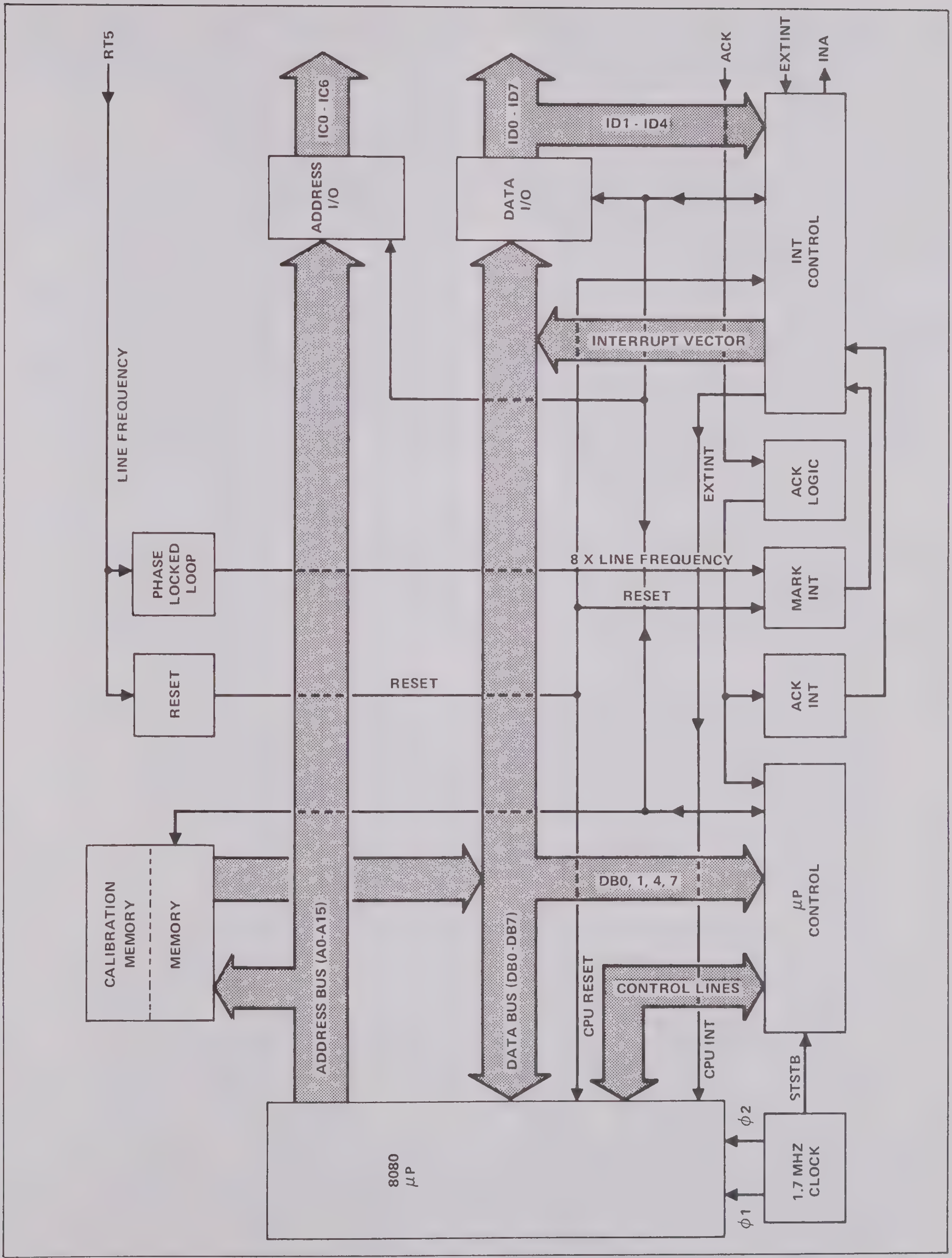

RT5
LINE FREQUENCY
PHASE LOCKED LOOP
RESET
CALIBRATION MEMORY
MEMORY
ADDRESS I/O
IC0 - IC6
ADDRESS BUS (A0-A15)
DATA I/O
ID0 - ID7
ID1 - ID4
DATA BUS (DB0-DB7)
8080 µP
ACK
EXTINT
INA
INT CONTROL
INTERRUPT VECTOR
EXTINT
ACK LOGIC
8 X LINE FREQUENCY
RESET
MARK INT
RESET
ACK INT
DB0, 1, 4, 7
µP CONTROL
CONTROL LINES
CPU RESET
CPU INT
STSTB
φ2
φ1
1.7 MHZ CLOCK

Figure 3-5. Controller Block Diagram

the accompanying data determine which digit or annunciator will light and which segments will light. An indirect address requires a previous, valid direct address to set up the indirect response. Another direct address enables the switch matrix to be read to determine if any function changes are desired. The cycle of updating each digit and annunciator and reading the switch matrix requires approximately 28 ms and is continuous. Input terminals, J1-J5, are physically located on the front panel but have no electrical interaction with the front panel.

3-22. DC Signal Conditioner

3-23. DC signals from either the input terminals or optional signal conditioners (Ohms or Current Shunts) are routed through the DC Signal Conditioner to be brought within the range of the A/D Converter (± 20V). Figure 3-6 is a block diagram of the DC Signal Conditioner. Gain or attenuation factors are selected by the microprocessor addressing the module. Data from the data bus is latched into the control circuitry and used to select relays in the attenuator and switched in the amplifier feedback circuit. The combination of the attenuator and feedback-controlled amplifier give gain factors of 1, 10, or 100 and attenuation factors of 8 or 64.

3-24. Active Filter

3-25. The purpose of the Active Filter module is to multiplex dc signals to the A/D Converter and to switch analog filters into the signal path. Figure 3-7 is a block diagram of the Filter/External Reference module. Five filter modes may be selected from the front panel. For external reference measurements, the signal conditioner input, the External Reference HI input and the External Reference LO input are mulitiplexed to the A/D Converter. Samples are taken of each input and arithmetically manipulated by the Controller to arrive at a reading. Outputs from the optional ac converter modules are applied to the Active Filter module, bypassing the DC Signal Conditioner.

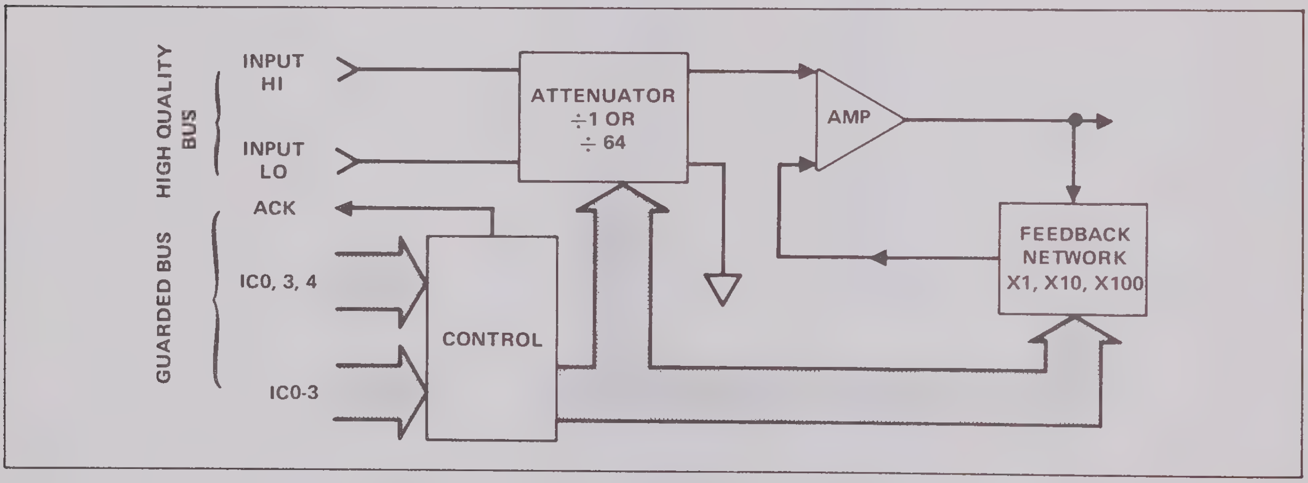

HIGH QUALITY BUS
GUARDED BUS
INPUT HI
INPUT LO
ACK
IC0, 3, 4
IC0-3
ATTENUATOR ÷1 OR ÷ 64
AMP
CONTROL
FEEDBACK NETWORK X1, X10, X100

Figure 3-6. DC Signal Conditioner Block Diagram

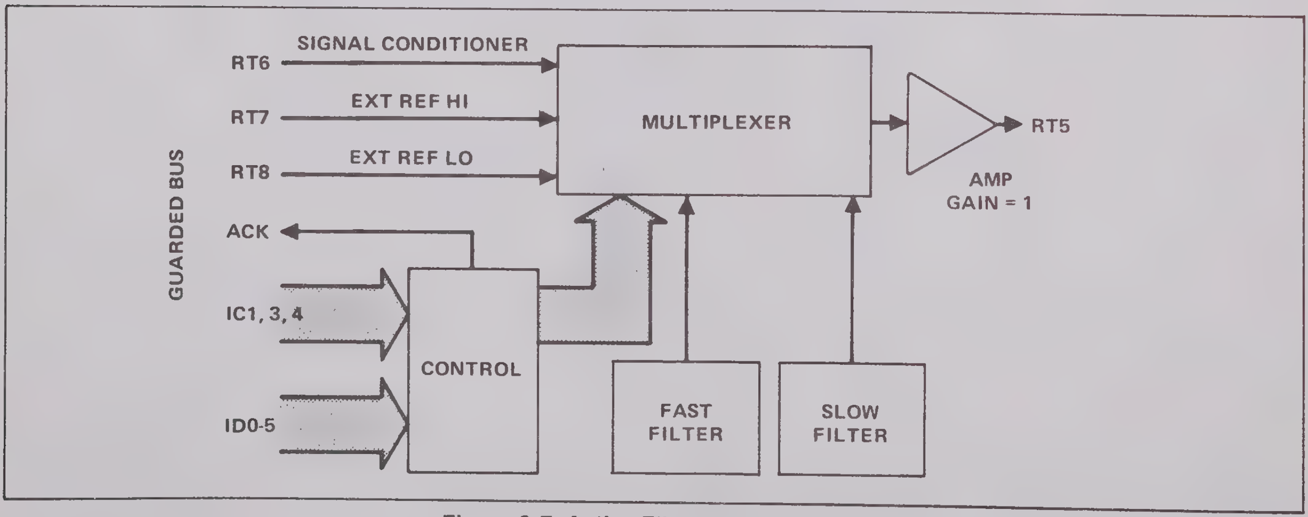

GUARDED BUS
RT6
SIGNAL CONDITIONER
RT7
EXT REF HI
RT8
EXT REF LO
ACK
IC1, 3, 4
ID0-5
MULTIPLEXER
RT5
AMP GAIN = 1
CONTROL
FAST FILTER
SLOW FILTER

Figure 3-7. Active Filter Block Diagram

3-26. Fast R² A/D Converter

3-27. The Fast R² A/D Converter employs Fluke's patented recirculating remainder (R²) technique for converting a dc input signal into a binary, bit-serial data stream. The R² technique has been modified for microprocessor control. Obtaining a sample is a five-step process. Each step consists of a decision period of five decisions and a subtraction period. Set-up of the converter, decisions, and reset are initialized by the Controller addressing the A/D Converter. Figure 3-8 is a block diagram of the R² A/D Converter.

3-28. During the first step, the input signal is applied to the Summing Node. The polarity of the input is detected and the resulting bit of information is transmitted to the Controller. On the basis of the returned polarity, the A/D module selects which reference polarity is required: positive for negative inputs, negative for positive inputs. The first of five precision currents is switched into the Summing Node and a polarity bit returned. If the polarity is changed the first current is switched off. If the polarity is not changed, the current is left on. Then the next current is switched into the Summing Node and another polarity bit returned. Another decision is made and so on until all five currents have been switched into the Summing Node and five decisions have been made. This completes the first decision period. The five precision currents are related by powers of two. The fifth current has a resolution of thirty two.

3-29. Following the decision period is a subtraction period. Feedback through the Remainder Storage nulls whatever remainder was left after the five currents have been switched into the Summing Node. The remainder is amplified by 16 in the Remainder Amp and is stored on a capacitor in Remainder Storage. This completes the first step. The input is now switched out of the Summing Node and the amplified remainder switched in for the next step. There are two remainder channels in Remainder Storage and they are alternated in the four subsequent steps. Since the fifth current has a resolution of thirty two and the Remainder Amp has a gain of 16, the first bit of a step has the same significance as the last bit of the previous step.

3-30. Of the five steps required to complete a sample, the first uses the input signal for decision and subtraction periods. The four subsequent steps alternate remainder channels to use the amplified remainder of the preceding step for decision and subtraction periods. Polarity bits returned at each decision are accumulated by the Controller and assembled into a 24-bit word describing the polarity and magnitude of the input.

3-31. Front/Rear Switch Assembly

3-32. Analog inputs are applied either at front panel terminals or through a rear panel connector. The Front/Rear Switch Assembly is controlled by the Rear Input Selector on the front panel. When disengaged (out), this selector routes front panel INPUT HI and LO,

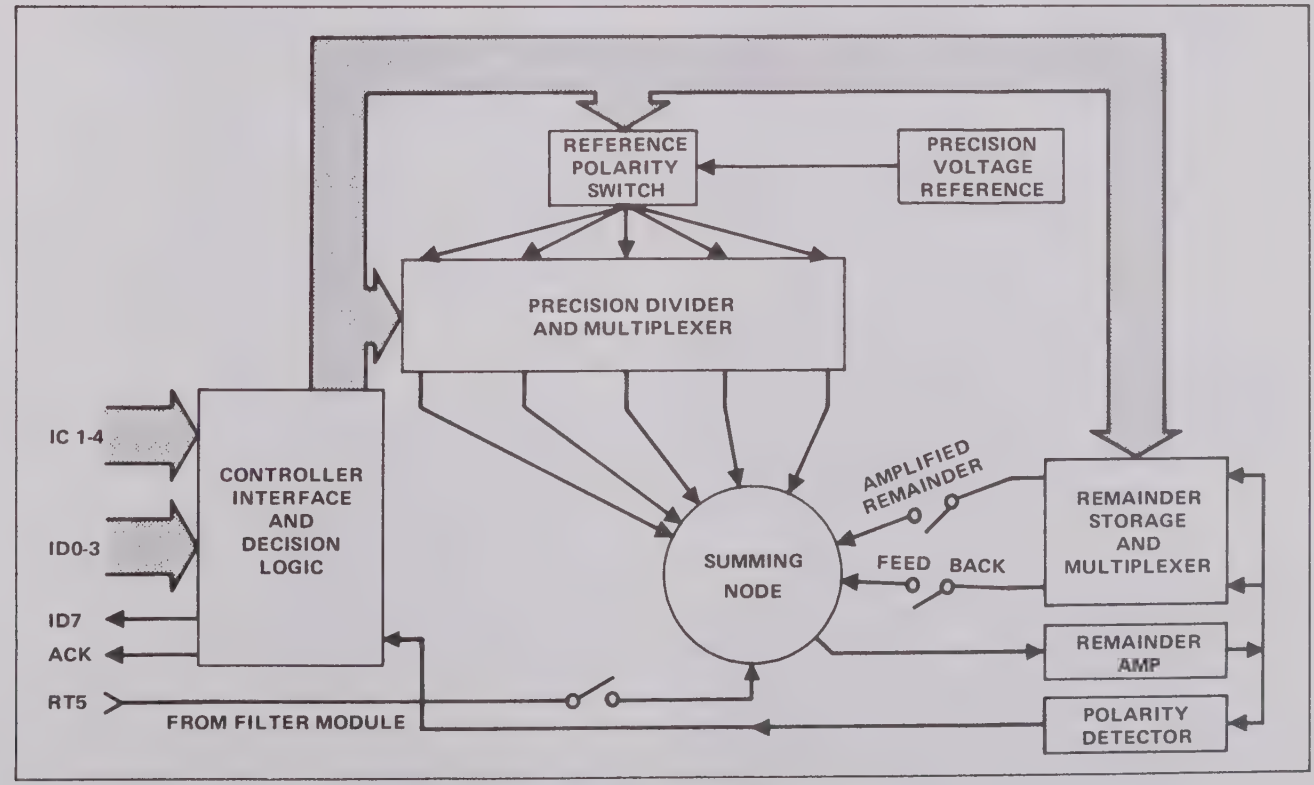

REFERENCE POLARITY SWITCH
PRECISION VOLTAGE REFERENCE
PRECISION DIVIDER AND MULTIPLEXER
IC 1-4
ID0-3
ID7
ACK
RT5
CONTROLLER INTERFACE AND DECISION LOGIC
FROM FILTER MODULE
SUMMING NODE
AMPLIFIED REMAINDER
FEED BACK
REMAINDER STORAGE AND MULTIPLEXER
REMAINDER AMP
POLARITY DETECTOR

Figure 3-8. R² A/D Converter Block Diagram

SOURCE HI and LO, and GUARD connections to the multimeter analog bus. The front panel Ohms Selector and Guard Selector influence only the front panel inputs: these two selectors have no effect on the rear inputs. When engaged (in), the Rear Input Selector routes INPUT HI and LO, SOURCE HI and LO, GUARD, and OHMS GUARD from the rear input connector to the analog bus. External Reference HI and LO inputs are also applied through the rear input connector but are not switched. Separate fuse protection is used for front panel (INPUT HI, SOURCE HI) and rear (INPUT HI, SOURCE HI, GUARD) inputs. An LED on the Front/Rear Switch Assembly lights when front inputs are selected. The multimeter Controller senses this indication through a phototransistor on the Motherboard. Front input selection is also sensed by the IEEE-488 Bus.

3-33. CIRCUIT ANALYSIS

3-34. Introduction

3-35. Detailed circuit description of each module in the standard mainframe is presented in the following paragraphs. Optional modules are covered in Section 6. The block diagram description should be read first to get an understanding of the overall functioning of the instrument. Schematic diagrams are located in Section 8 (Section 6 for optional modules). Table 3-1 is a list of mnemonic definitions used in the Controller schematic.

3-36. Controller

3-37. TIMING

3-38. Refer to Figure 3-9. Timing for the microprocessor is derived from a 12V, two-phase clock (Ø1 and Ø2). The two-phase clock is generated by clock generator U14, which is designed to meet the timing requirements of the microprocessor. The clock generator also uses internal logic and a SYNC pulse from the microprocessor to generate an STSTB signal (which clocks microprocessor status information). The period of the Ø1 clock (585 ns) governs the duration of a machine cycle; there are three to five states in a machine cycle and one to five machine cycles in an instruction cycle.

3-39. Shaped line frequency pulses are applied to phase-locked loop U4 which, in conjunction with divide-by-eight counter U3, generates eight times the line frequency (480Hz for 60Hz line and 400Hz for 50Hz line). Line synchronization is achieved by using the output of the phase-locked loop to generate an internal interrupt (MARKINT).

3-40. ADDRESS AND DATA BUSES

3-41. ROM locations are decoded from A14 and A13, as chip selects and from A0 through A12. RAM locations are decoded from A14 and A11, as chip selects, and from A0 through A10. External modules are selected by setting A15 high. Inverted forms of A8 through A14 are sent out as IC0 through IC6 on the unguarded bus. The data bus lines (D0 through D7) are connected directly to internal memory and through tristate buffers to the external data bus (ID0 through ID7).

Table 3-1. Mnemonics

A0-A15	Address bus on controller
ACK	Acknowledge signal from module
ACKINT	Interrupt generated when module does not respond
CPUINT	Interrupt signal for μP
CPUREADY	Ready signal for μP
CPURESET	Reset signal
D0-D7	Data bus on controller
DBIN	Data bus input signal (from μP)
DLDACK	Delayed version of ACK
EXTCOM	Module communication signal
EXTINT	Interrupt from module
FLINE	Shaped line frequency signal
8xFLINE	8 times line frequency
FRONT/REAR	Front or rear input signal
IC0-IC7	Module address/control bus
ICENABLE	Enable module address signal
ID0-ID7	Module data bus
INA	Interrupt acknowledge signal in response to EXTINT
INP	I/O status signal
INTA	Interrupt acknowledge status signal
INTCLR	Clear interrupt signal
LINEREF	Line reference signal, bus input on RT5
MARKINT	Interrupt to synchronize to line frequency
Ø1	One phase of μP clock
Ø2	Other phase of μP clock
OUT	I/O status signal
READY	Signal to generate CPUREADY
RESET	Reset signal
RUN	Exit wait state signal
SCANADV	Scan advance signal, A/D conversion complete
STOP	Enter wait state signal
STSTB	Clock signal to latch μP status
SYNC	Signal from μP, used to generate STSTB
SYNCDEXTINT	Synchronized interrupt from module
Vbb	-5V supply
Vcc	+5V supply
Vdd	+12V supply
Vgg	-12V supply
Vss	Logic common
WAIT	μP in wait state signal
WR	Write data signal from μP

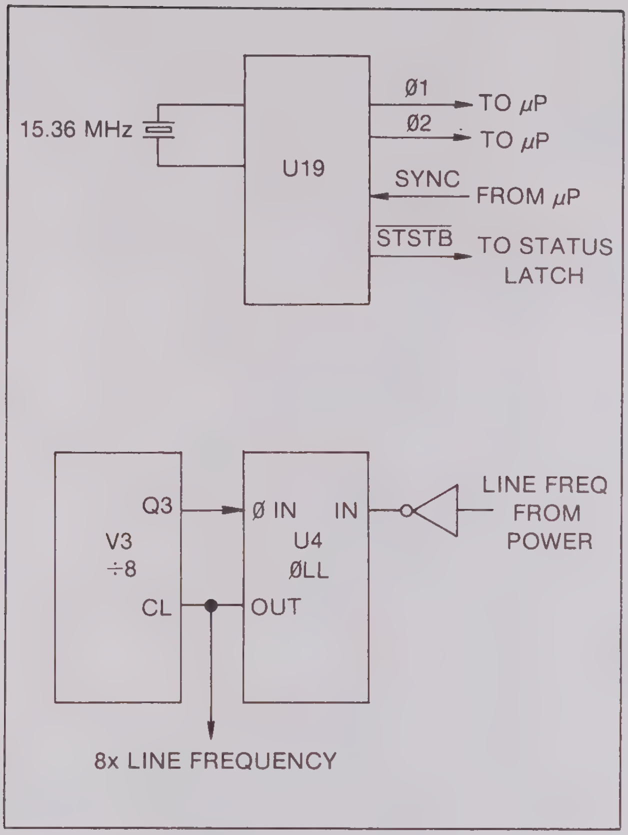

15.36 MHz
U19
Ø1
TO µP
Ø2
TO µP
SYNC
FROM µP
STSTB
TO STATUS LATCH
Q3
V3
÷8
CL
Ø IN
IN
U4
ØLL
OUT
LINE FREQ FROM POWER
8x LINE FREQUENCY

Figure 3-9. Timing Circuits

3-42. RESET

3-43. Refer to Figure 3-10. Shaped line frequency pulses are applied to U2 and U3, providing a hardware reset on power down, power up, or for missing line cycle pulses. In any of these three reset conditions, retriggerable one shot U2 (T=40 ms) generates a reset pulse for up counter U3. After the reset to U3 is removed (delayed Vcc high or a line frequency pulse), U3 must be clocked by eight line frequency pulses to raise Q4 high and remove the reset signal. The reset pulse is held for eight line cycles to allow time for the power supplies and microprocessor oscillator to stabilize.

3-44. STATUS LATCH

3-45. Refer to Figure 3-11. During the first state of every machine cycle, the microprocessor sends out a status word on the data bus. This status word contains the information for external logic to synchronize with microprocessor activity (e.g., memory read, interrupt acknowledge). Clock signal STSTB (from U19) clocks this information into quad D-type flip-flop U12 for use during the machine cycle. External interrupts are also latched into the status latch for synchronization to the microprocessor.

3-46. WAIT LOGIC

3-47. Refer to Figure 3-12. When the microprocessor addresses an external module, the wait state logic forces the microprocessor to enter a wait state and allow the module time to respond. When the microprocessor acknowledges an interrupt, the wait state is similarly forced to allow time for the interrupt vector to be generated. A wait state is entered when a rising edge on STOP (the clock input U1) sets READY low. Clock generator U19 then synchronizes READY to the timing requirements of the microprocessor and pulls CPUREADY low.

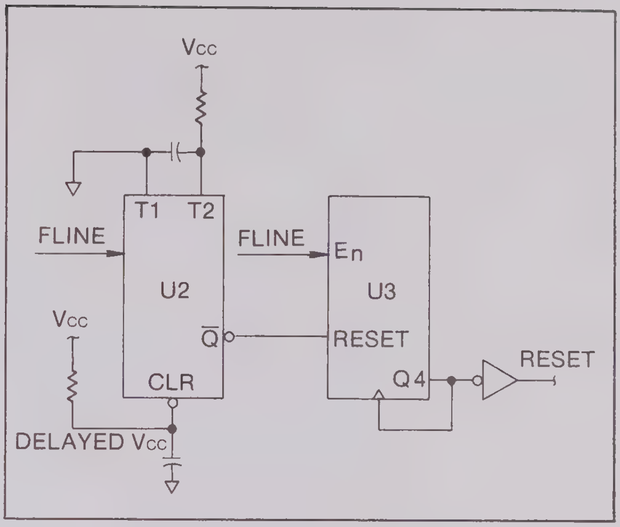

Vcc
T1
T2
FLINE
U2
Vcc
Q
CLR
DELAYED Vcc
FLINE
En
U3
RESET
Q4
RESET

Figure 3-10. Reset Logic

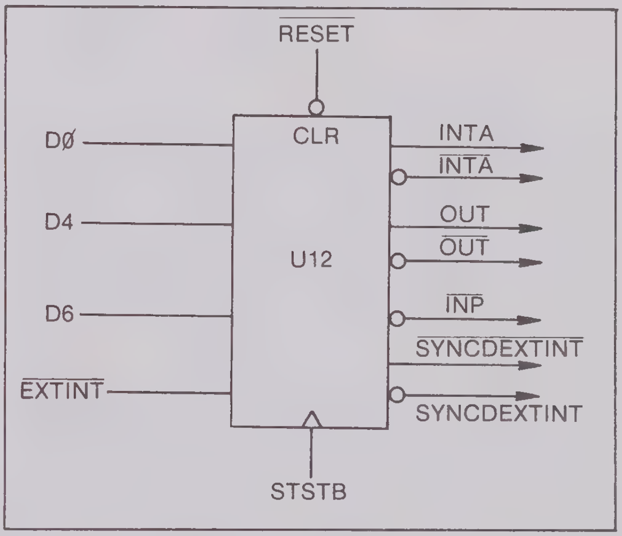

RESET
CLR
DØ
D4
D6
EXTINT
U12
STSTB
INTA
INTA
OUT
OUT
INP
SYNCDEXTINT
SYNCDEXTINT

Figure 3-11. Status Latch

3-48. To exit the wait state, RUN (the clear input to U1) must be pulled low. Two events cause this to happen. ACKINT is asserted by the interrupt circuitry if the addressed module does not return an ACK in a specific time period. Alternately, DLDACK is asserted. DLDACK is asserted by a module returning an ACK or by response to a MARKINT.

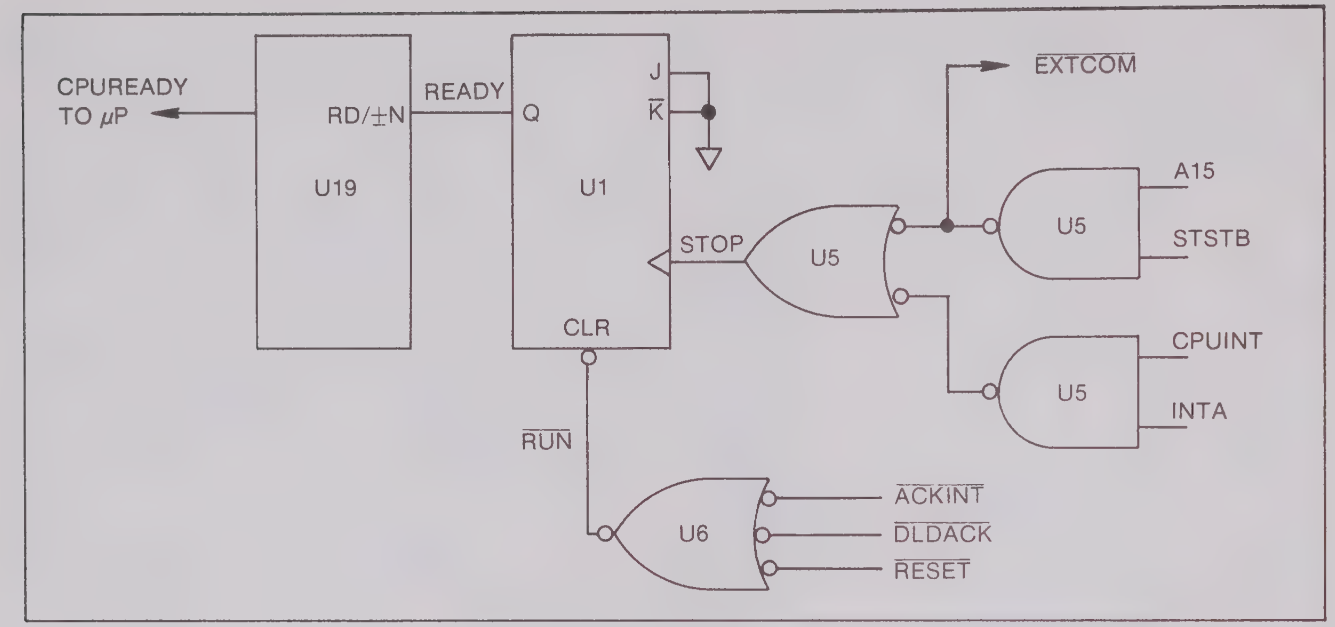

CPUREADY TO μP
RD/±N
U19
READY
Q
J
K̄
U1
STOP
CLR
RUN
U5
EXTCOM
A15
STSTB
CPUINT
INTA
ACKINT
DLDACK
RESET
U6

Figure 3-12. Wait Logic

3-49. ACK LOGIC

3-50. Refer to Figure 3-13. When a module is addressed by the controller or is enabled for interrupt identification by INA, it must return an ACK (high) to complete the handshake. ACK is delayed about 1.6 us to produce DKDACK. DLDACK is also generated in a MARKINT interrupt response cycle.

3-51. INTERRUPTS

3-52. Two possible internal interrupts (MARKINT and ACKINT) and three possible external interrupts (EXTINT) are able to drive CPUINT high and interrupt the microprocessor. The microprocessor samples the interrupt line at the end of each machine cycle. If an interrupt exists, the microprocessor asserts INTA in the status word of the next instruction fetch machine cycle. External logic is thereby enabled to place an interrupt vector (and not the next instruction) on the data bus. Refer to Figure 3-14.

3-53. Internal interrupts are ACKINT and MARKINT (Figure 3-14). The ACKINT logic consists of a retriggerable one-shot (U2) and a D-type flip-flop (U7). EXTCOM (A15 and STSTB) triggers U2. If DLDACK does not occur in the time constant of U2, U2 clocks U7 and asserts ACKINT. This action takes the microprocessor out of the wait state.

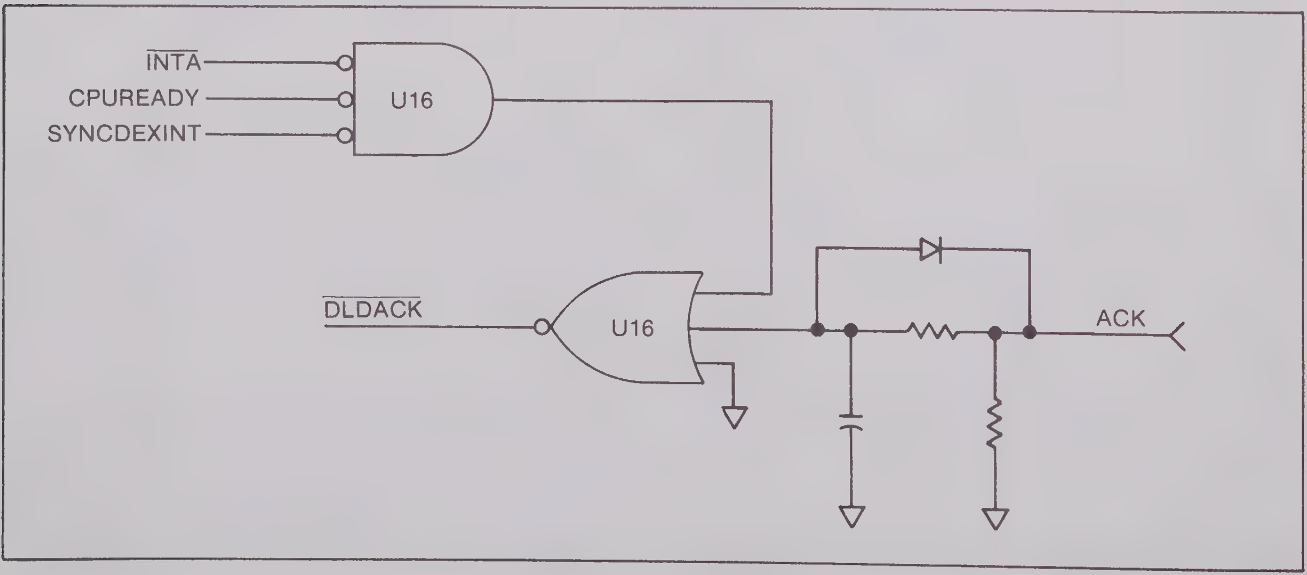

INTA
CPUREADY
SYNCDEXINT
U16
DLDACK
U16
ACK

Figure 3-13. ACK Logic

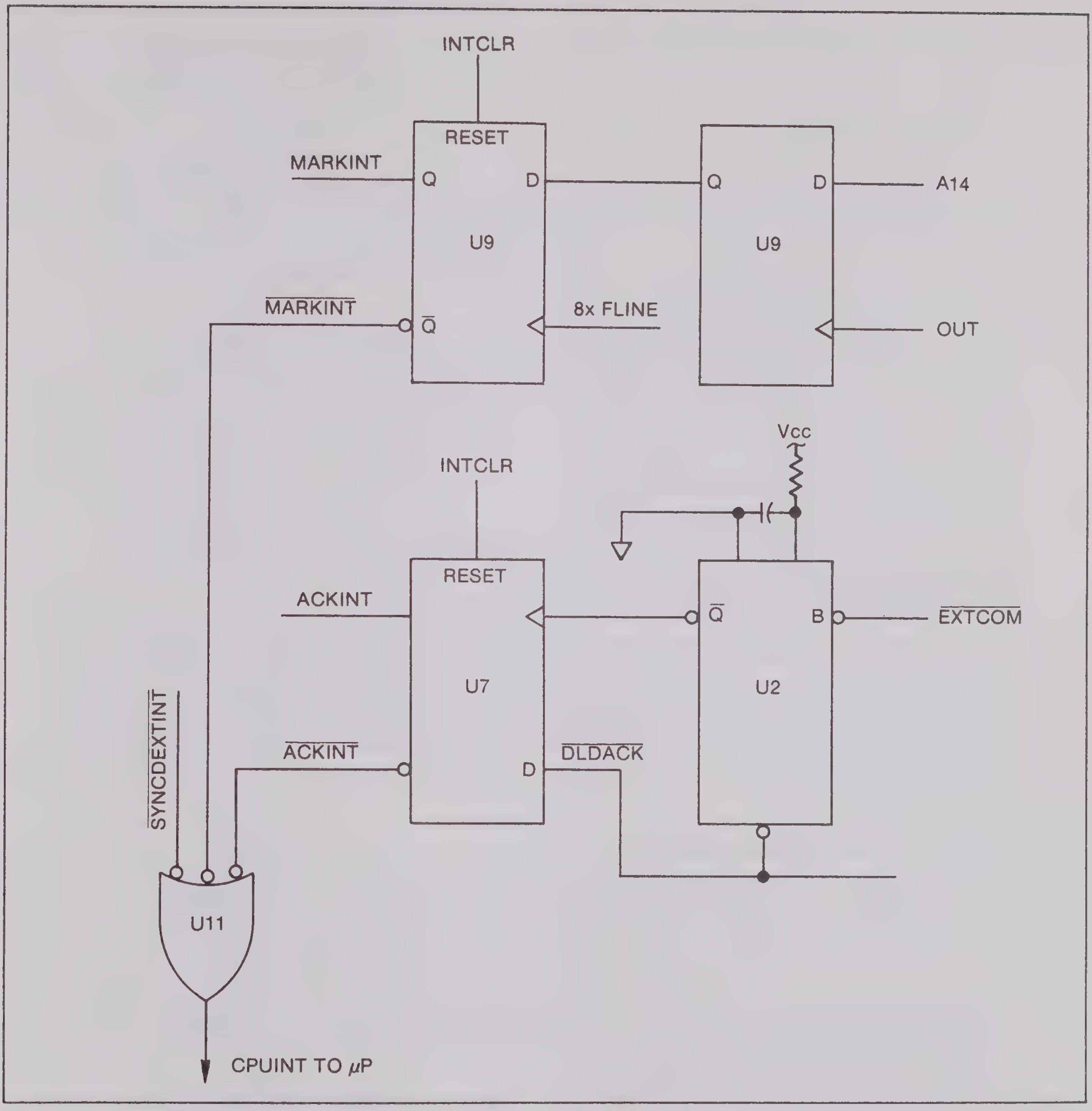

INTCLR
RESET
MARKINT
Q
D
U9
MARKINT
Q̄
8x FLINE
Q
D
A14
U9
OUT
Vcc
INTCLR
RESET
ACKINT
U7
Q̄
B
EXTCOM
U2
SYNCDEXTINT
ACKINT
D
DLDACK
U11
CPUINT TO μP

Figure 3-14. Interrupt Generation Logic

3-54. The MARKINT logic consists of two D-type flip-flops. The first (U9-1) can be written to enable or disable MARKINTS. The second (U9-12) is clocked by the eight times line frequency signal from the phase-locked loop.

3-55. Interrupts are prioritized by U-21 (refer to the controller schematic in Section 8). ACKINT interrupts have the highest priority, and MARKINT interrupts have the lowest priority. External modules must drive ID1, 2, or 3 high in response to INA, to generate the correct vector for that module.

3-56. Front Panel

3-57. Refer to Figure 3-15. Annunciator segment data is clocked into register one by the direct address, IC0, 1, 5 high. Data output from the switch matrix is also a direct address-IC0, 1, 6, high. For either direct address, the condition of ID7 (high for disable) is latched into U23 to enable an indirect address. Digit segment address-IC1, 5 high, and digit-annunciator select address-IC0, 5 are both indirect addresses. Data is clocked into the registers upon termination of the address. An update sequence is as follows:

1. Register 1 is addressed with all data lines low to blank the annunciator display and enable indirect addressing.

2. Register 2 is addressed indirectly with data lines low to blank the digit display.

3. Register 3 is addressed indirectly with all data lines high to turn off all LEDs, disable the switch matrix, and disable indirect addressing.

4. Register 1 is addressed with ID7 low to enable indirect addressing and with either annunciator segment data or digit 7SD data on ID0-6. The data is latched and applied to the annunciator LEDs (or to digit 7SD).

5. Register 2 is addressed with digit segment data on ID0-7 (U23 is not clocked by this address so ID7 may be high without disabling indirect addressing). The data is latched and applied to the digit LEDs.

6. Register 3 is addressed with ID7 high (disable indirect addressing) and one of the data lines, ID0-6 low to enable one digit LED and one annunciator LED. One bank of the switch matrix is also enabled.

7. The output buffer is addressed enabling the data from the previously enabled switch bank to be placed on the data bus. One or more lines being low indicates a change is desired. This address also keeps the kill circuit charged.

3-58. The seven steps just outlined are required for one digit-annunciator-switch bank update. The process is repeated seven times for a complete update. The kill circuit is used to blank the display if the Controller discontinues addressing the front panel.

3-59. DC Signal Conditioner

3-60. Relays K1 and K2 control the input to the DC Signal Conditioner and the attenuation of the input (Figure 3-16). If both relays are energized, the input is from the Volt/Ω input sense terminals with - 64 attenuation. If just K1 is energized, the input is from the Volt/Ω input terminals with no attenuation. If just K2 is energized, the input is from RT1 (optional signal conditioners). Q10, Q11, CR3, and CR4 provide overvoltage protection.

3-61. A differential amplifier (Q18, Q19) drives U3. FET switched (Q14, Q15, Q16) control the gain of Q18 and Q37. An output voltage swing of ±20V is achieved through bootstrapping; U4 provides a bootstrap for Q38 and Q37, and U5 and U6 provide a bootstrap for U3 and U4. Current sink and source for Q18 and Q19 are provided by Q38 and Q37 respectively.

3-62. The DC Signal Conditioner is addressed by IC0, 3, 4 high. Data on ID0-3 is latched up and decoded to determine which switches and relays will be energized. Figure 3-16 includes an example of the relay driver used to minimize thermal changes in the relays between the on and off states. RC coupling between the decoder and the relay driver provide voltage swings up to 4V or down to 0V to ensure positive relay action. Steady state voltages of 1.45V (off) and 2.75V (on) minimize current difference between the on and off states while maintaining the relay state under all conditions.

3-63. Filter/External Reference

3-64. All inputs to the A/D Converter are routed through the Filter/External Reference module. Refer to Figure 3-17. External measurements are made by multiplexing the three filter module inputs to the A/D Converter. Q18, Q19, and Q20 switch the signal conditioner input, the external reference LO input, and the external reference HI input respectively. Data controlling the switches is latched into U1 upon termination of the address (IC1, 3, 4 high).

3-65. Three-pole, active Bessel filters (U3 and U4) have different setting times and cut-off points. Either filter may be selected from the front input panel for application to the signal conditioner input. Bypass is automatically selected for external reference inputs and may be selected for signal conditioner inputs. The combination of Q32, Q25, Q23, Q24, or Q21, Q22 is turned on to select a filter mode.

3-66. A dual, super-beta transistor in a differential configuration (Q27) drives U5. A current source (Q26) and sink (Q30) bias Q27. Enough current is drawn through R19 by Q26 to bootstrap the input amplifier, Q27, 5V above the output. Gain of the amplifier is set at one by the combination of R21 and the input resistors. The external reference inputs have additional series resistors located on the Front/Rear Input Assembly.

3-67. Fast R² A/D Converter

3-68. The Fast R² A/D Converter may be separated for analysis into two component groups: analog and digital. Analog circuitry is responsible for producing a voltage reference, for summations, and for remainder amplification and storage. Digital circuitry interfaces the analog circuitry to the Contoller and is responsible for reference selection, decision in the summation process, remainder channel control, and autozeroing. Since functions within the A/D Converter are either directly controlled by the Controller module via the data bus or are clocked through their operations by the Controller addressing the A/D module, the A/D conversion program could be considered a functional part of the A/D Converter.

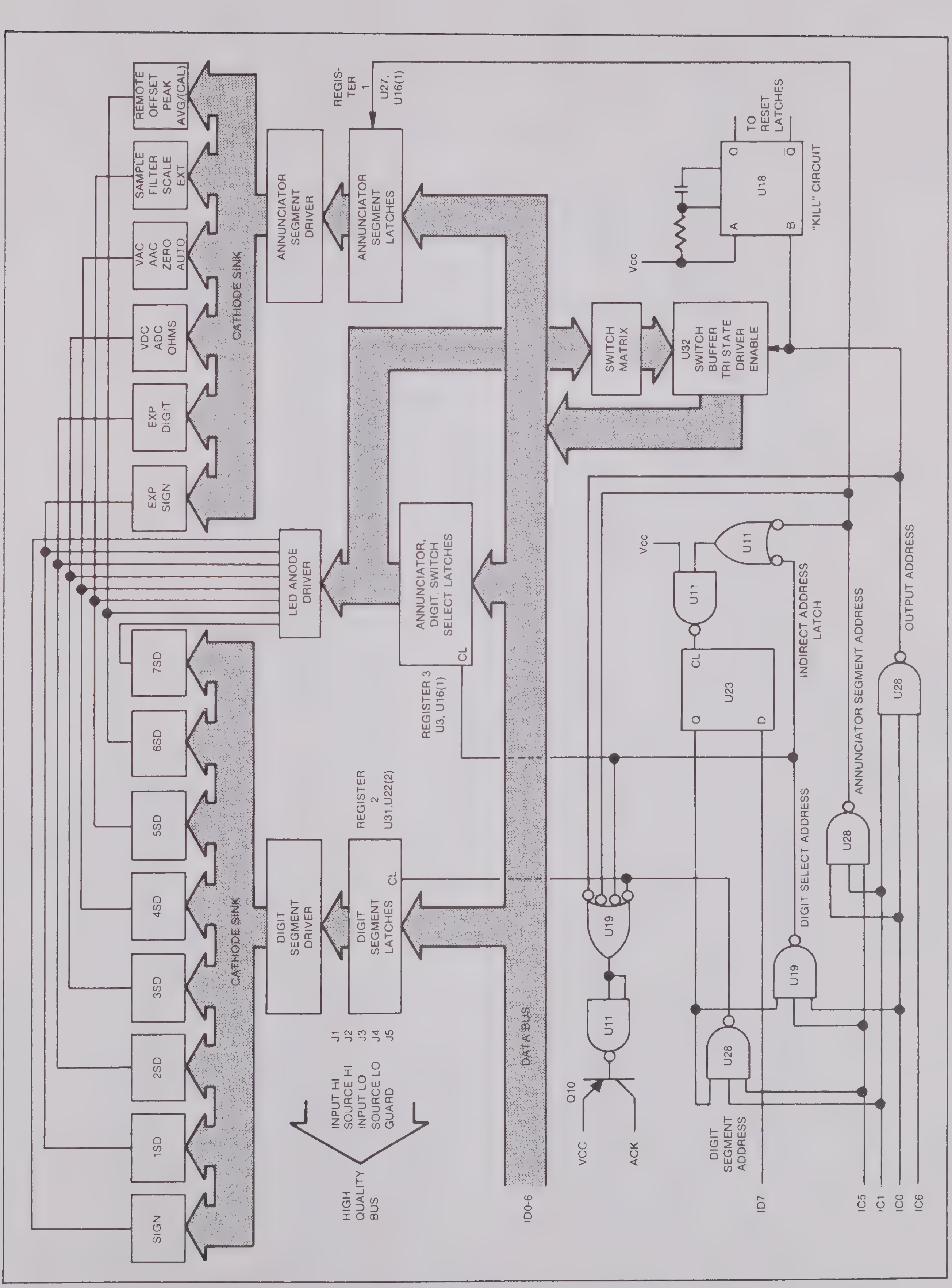

REMOTE
OFFSET
PEAK
AVG/(CAL)
SAMPLE
FILTER
SCALE
EXT
VAC
AAC
ZERO
AUTO
VDC
ADC
OHMS
EXP DIGIT
EXP SIGN
CATHODE SINK
7SD
6SD
5SD
4SD
3SD
2SD
1SD
SIGN
CATHODE SINK
ANNUNCIATOR SEGMENT DRIVER
ANNUNCIATOR SEGMENT LATCHES
REGISTER 1
U27, U16(1)
LED ANODE DRIVER
ANNUNCIATOR, DIGIT, SWITCH SELECT LATCHES
CL
REGISTER 3
U3, U16(1)
DIGIT SEGMENT DRIVER
DIGIT SEGMENT LATCHES
CL
REGISTER 2
U31,U22(2)
INPUT HI J1
SOURCE HI J2
INPUT LO J3
SOURCE LO J4
GUARD J5
HIGH QUALITY BUS
DATA BUS
ID0-6
SWITCH MATRIX
U32 SWITCH BUFFER TRI STATE DRIVER ENABLE
Vcc
U18
A
B
Q
Q̄
TO RESET LATCHES
"KILL" CIRCUIT
Vcc
U11
U11
CL
U23
Q
D
INDIRECT ADDRESS LATCH
U28
OUTPUT ADDRESS
ANNUNCIATOR SEGMENT ADDRESS
U28
DIGIT SELECT ADDRESS
U19
U19
U11
Q10
VCC
ACK
U28
DIGIT SEGMENT ADDRESS
ID7
IC5
IC1
IC0
IC6

Figure 3-15. Front Panel

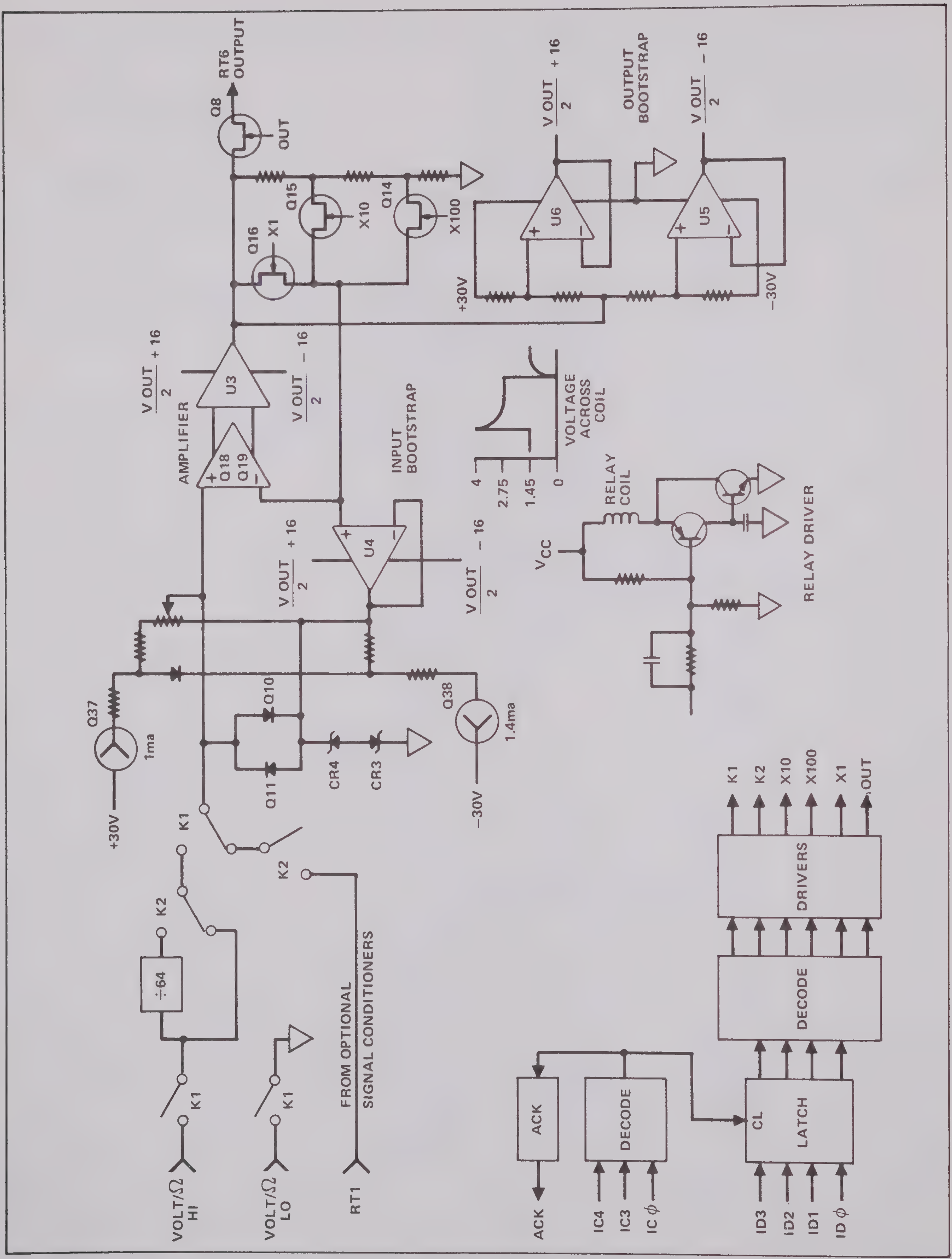

RT6 OUTPUT
Q8
OUT
Q16
X1
Q15
X10
Q14
X100
$\frac{V\,OUT}{2} + 16$
$\frac{V\,OUT}{2} - 16$
OUTPUT BOOTSTRAP
U6
U5
+30V
−30V
AMPLIFIER
U3
Q18
Q19
INPUT BOOTSTRAP
U4
VOLTAGE ACROSS COIL
4
2.75
1.45
0
RELAY COIL
V_{CC}
RELAY DRIVER
Q37
1ma
Q10
Q11
CR4
CR3
Q38
1.4ma
K1
K2
÷64
VOLT/Ω HI
VOLT/Ω LO
FROM OPTIONAL SIGNAL CONDITIONERS
RT1
ACK
DECODE
CL
LATCH
DECODE
DRIVERS
K1
K2
X10
X100
X1
OUT
IC4
IC3
IC φ
ID3
ID2
ID1
ID φ

Figure 3-16. DC Signal Conditioner

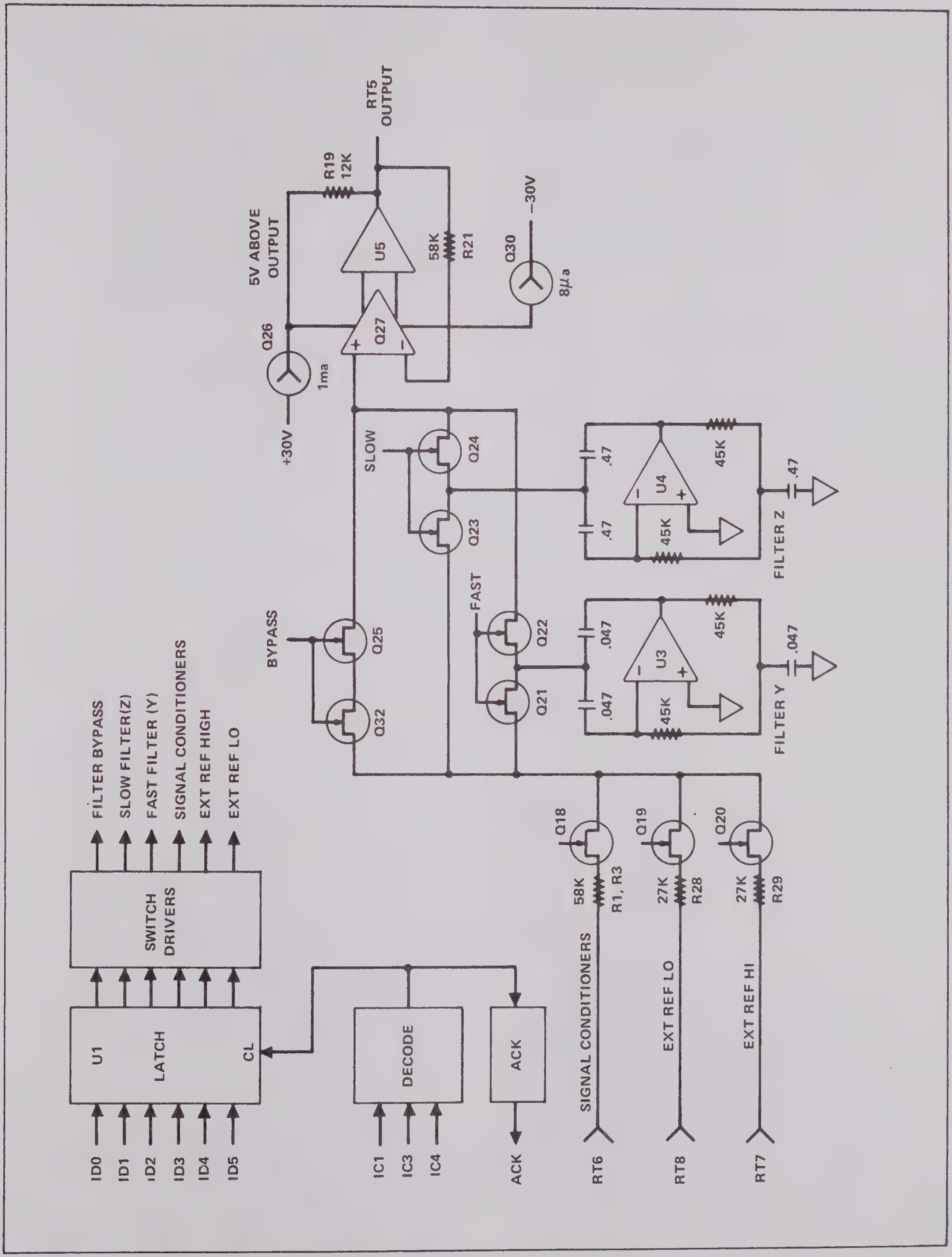

ID0
ID1
ID2
ID3
ID4
ID5
U1
LATCH
CL
SWITCH DRIVERS
FILTER BYPASS
SLOW FILTER(Z)
FAST FILTER (Y)
SIGNAL CONDITIONERS
EXT REF HIGH
EXT REF LO
IC1
IC3
IC4
DECODE
ACK
ACK
RT6
RT8
RT7
SIGNAL CONDITIONERS
EXT REF LO
EXT REF HI
58K
R1, R3
27K
R28
27K
R29
Q18
Q19
Q20
BYPASS
Q25
Q32
FAST
Q22
Q21
SLOW
Q24
Q23
.047
.047
45K
45K
U3
FILTER Y
.047
.47
.47
45K
45K
U4
FILTER Z
.47
+30V
Q26
1ma
5V ABOVE OUTPUT
Q27
U5
R19
12K
58K
R21
Q30
8μa
-30V
RT5
OUTPUT

Figure 3-17. Filter/External Reference

3-69. ANALOG

3-70. Figure 3-18 is a simplified schematic of the analog portion of the A/D Converter. For clarity, switches are shown as a circle enclosing a letter designator. U1 is a reference and reference amplifier controlling U2, a current source. The –7V reference is set by R9 and R14. U3 serves as a highly regulated collector and zener supply for U1. Operation of the A/D Converter requires both a positive and negative reference (for negative and positive inputs, respectively). Q9 and U4 are a precision unity gain amplifier whose input is controlled by switches A1 and A2. With A1 closed and A2 open, Q9 and U4 are a noninverting amplifier.

3-71. An input signal is applied to the Summing Node of the remainder amplifier (Q27, U7) through switch I. Q27 and U7 are an inverting amplifier with two gain configurations. During the decision period, switch G is closed, applying the output of U7 to polarity detector Q28 and forming a feedback path through CR5 and CR6. Q28 sends a polarity bit to the digital portion of the circuitry. On the basis of this first polarity bit, a reference polarity is selected.

3-72. Switches B, C, D, E, and F are closed, one at a time, to switch a precise amount of current into the Summing Node. When a switch is closed, the opposite switch is opened and vice versa. For example, when D is closed, $\bar{D}$ is opened. After a switch is closed, a polarity bit is returned. If the polarity changed with respect to the original polarity selected for a step, the switch is opened; otherwise it is left closed. The next switch is closed, a polarity bit returned and a decision made, and so on until all five switches have been closed (and possibly opened again). This constitutes a decision period.

3-73. Following the decision period is the subtraction period. Switch G is opened and switches X and SX are closed to form a feedback path for the remainder amplifier through the X channel, A 400K resistor, R35, sets the gain of Q27 and U7 at sixteen. The feedback current completes the summation process and the amplified remainder is stored on the C10 in the X channel.

3-74. For the next decision period switches SX and X are opened and switches RX and G are closed. Since Q27 and U7 form an inverting amplifier, the opposite polarity reference from the original selection is automatically selected. The amplified remainder is applied to the Summing Node through U6 and R34. Five decisions are made, followed by a subtraction period using channel Y for feedback and remainder storage. The first decision-subtraction period applies the input signal to the Summing Node. The four following steps apply an amplified remainder, alternating between channel X and channel Y.

3-75. When a sample is complete, the circuits are autozeroed. U8 zeros the remainder amplifier through channel X. Any offset is stored on C13 at the noninverting input of Q27. The switching reference, Q9 and U4, is zeroed by first closing A1 and opening A2 to decrease settling time. Then A1 and A2 are both opened and the Z1 and Z2 switches are closed, storing any offset error on C5.

3-76. DIGITAL

3-77. For the following discussion, refer to the Digital Fast R^2 A/D schematic in Section 8. Direct address IC2, 3, 4 latches data into U34 and U35 controlling input switch I, remainder channel switches, autozero, and reset (digital). U31, a ring counter, is clocked to the C1 state enabling the indirect address decoder (U33) and the polarity detector (switch G). A polarity bit is returned and applied to U6.

3-78. Indirect address IC1, IC2 latches the polarity bit in U6, enables the tristate transmitter, U5, and clocks U31 to the C2 state. The transition of U31 from C1 to C2 clocks the polarity into U11 (the uppermost section) whose output determines whether switch A1 or A2 will be closed (reference polarity). At the same time, U1 (uppermost section) is clocked to set the other section of U11, closing the first reference switch, B, of the A/D Converter. The next indirect address clocks a new polarity bit (a result of closing the first reference switch B) into U6. If the polarity changed, the output of U6 will cause a reset of the previous switch latch, opening the previous switch. At termination of the address the next switch is closed. One direct address and six indirect addresses are required to complete a step. The last indirect address resets the control logic to the C0 state.

3-79. Switch selections are made through switch drivers which rely on Vcc and Vss being a –15V and –20V with respect to analog common. This allows simple transition from TTL levels to FET off voltages. D/A Converter switches are selected on transition of U31 from one state to the next. The transition clocks the first of two D-type flip-flops which sets the second. The output of the second latch resets the first and selects the switch. If the polarity does not change after closing a switch, the output of U6 plus the output of U11 (reference select) will place two highs on the input of one section of AND gate U25. Through OR gate, U16, a one will be applied to the D input of that switch latch. The next transition of U31 will clock the latch, keeping the switch closed. If the polarity had changed, a zero would be applied to the D input, opening the switch.

3-80. After the last step, at completion of a sample, the Controller addresses the A/D Converter for autozero. U31 is clocked to the C7 state causing a digital reset. When U6, storage capacitor disable, is reset, autozero is enabled. RC coupled gates delay the zero switch controls so that switch A1 may be closed and A2 opened in the reference switching circuit. This provides a faster settling time for the reference switching amplifier. Both A1 and A2 are opened during the autozero time.

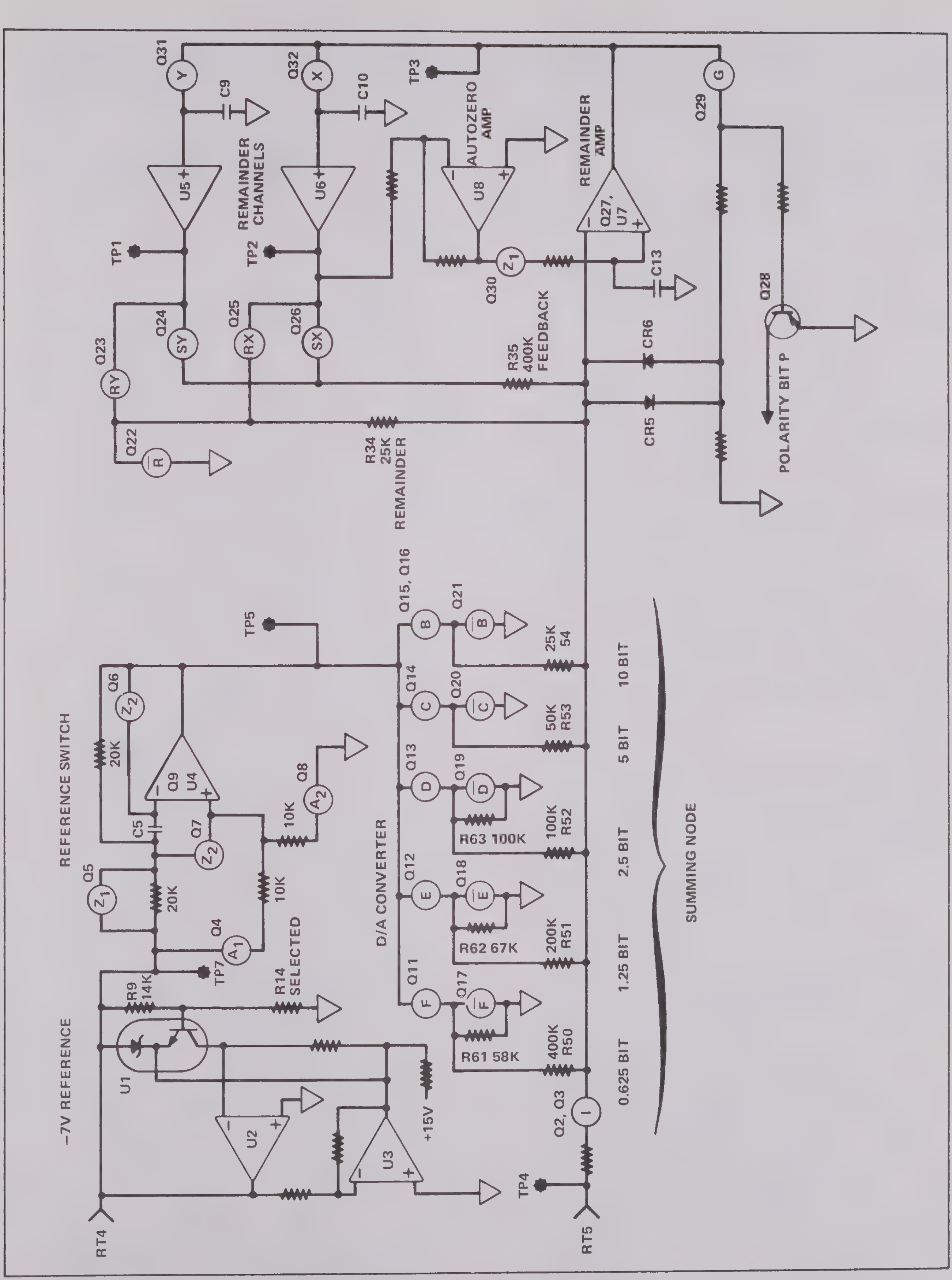
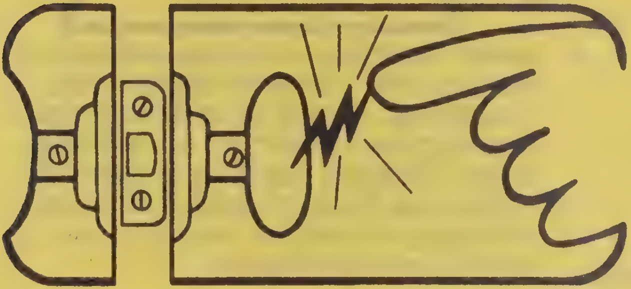

-7V REFERENCE
REFERENCE SWITCH
U1
U2
U3
+15V
RT4
RT5
TP4
TP7
TP5
R9 14K
R14 SELECTED
Q4
A1
Q5
Z1
20K
10K
Q7
Z2
C5
Q9 U4
Q6
Z2
20K
10K
Q8
A2
D/A CONVERTER
Q2, Q3
I
Q11
F
Q12
E
Q13
D
Q14
C
Q15, Q16
B
Q17
F
Q18
E
Q19
D
Q20
C
Q21
B
R61 58K
R62 67K
R63 100K
400K R50
200K R51
100K R52
50K R53
25K 54
0.625 BIT
1.25 BIT
2.5 BIT
5 BIT
10 BIT
SUMMING NODE
R34 25K REMAINDER
R35 400K FEEDBACK
Q22
R
Q23
RY
Q24
SY
Q25
RX
Q26
SX
TP1
TP2
TP3
U5
U6
REMAINDER CHANNELS
Q31
Y
Q32
X
C9
C10
AUTOZERO AMP
U8
Q30
Z1
REMAINDER AMP
Q27, U7
C13
CR5
CR6
Q28
Q29
G
POLARITY BIT P

Figure 3-18. Fast R^2 A/D Converter (Analog)

static awareness

A Message From

John Fluke Mfg. Co., Inc.



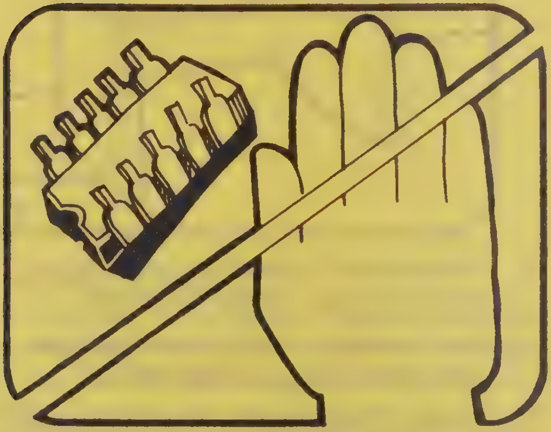
Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, and packaging and bench techniques that are recommended.

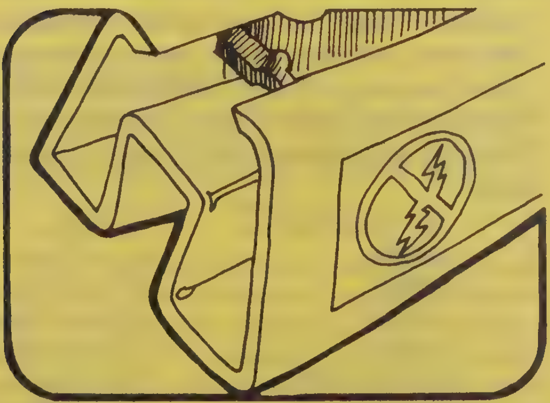
The Static Sensitive (S.S.) devices are identified in the Fluke technical manual parts list with the symbol

" ⊗ "

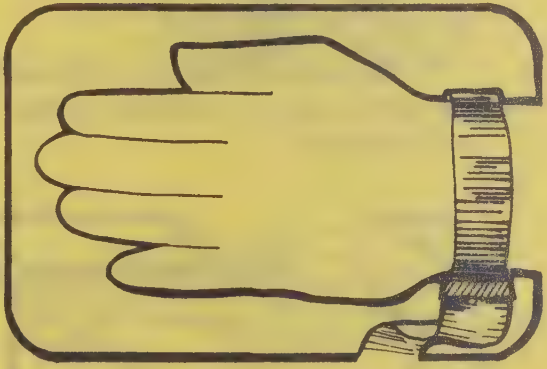
The following practices should be followed to minimize damage to S.S. devices.



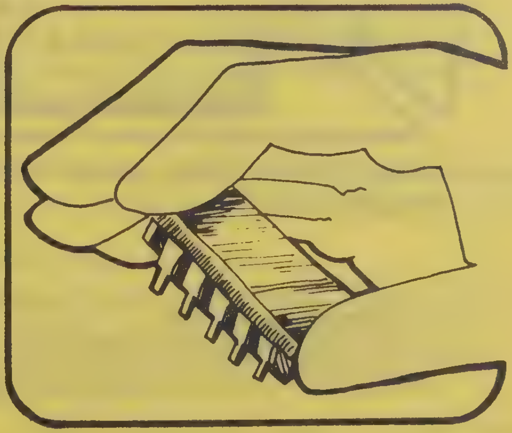
1. MINIMIZE HANDLING



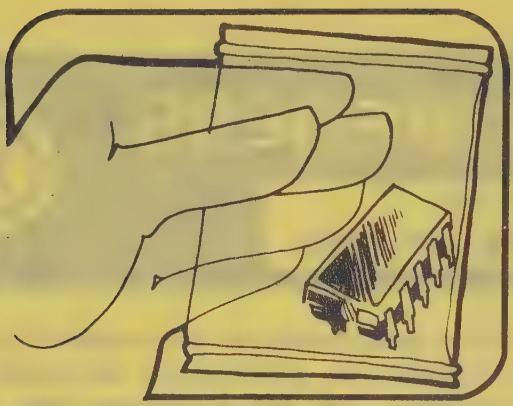
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



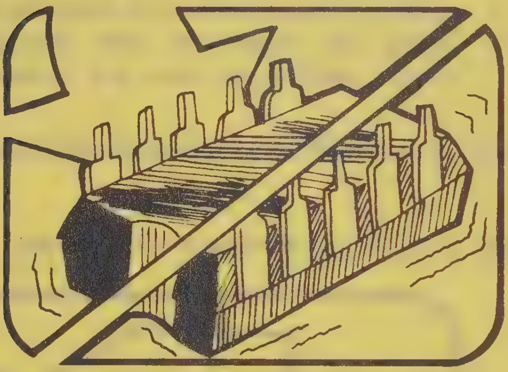
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES



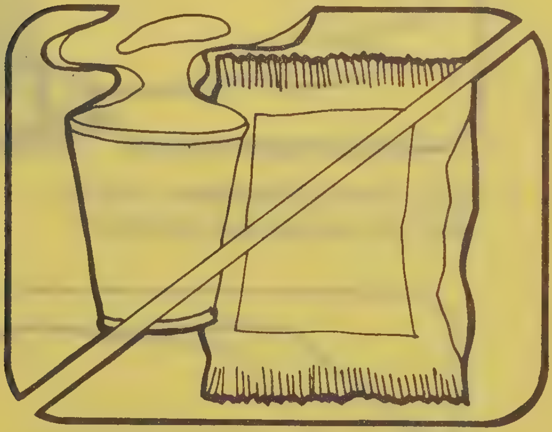
4. HANDLE S.S. DEVICES BY THE BODY



5. USE ANTI-STATIC CONTAINERS FOR HANDLING AND TRANSPORT



6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE



7. AVOID PLASTIC, VINYL AND STYROFOAM® IN WORK AREA

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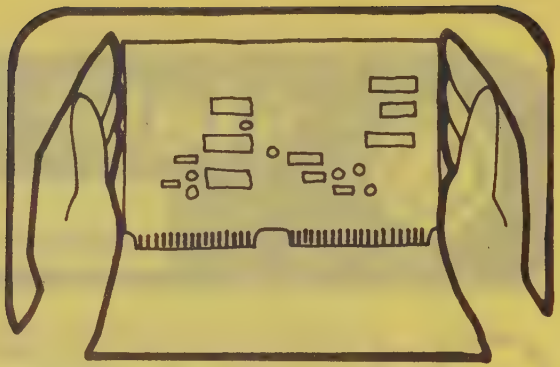
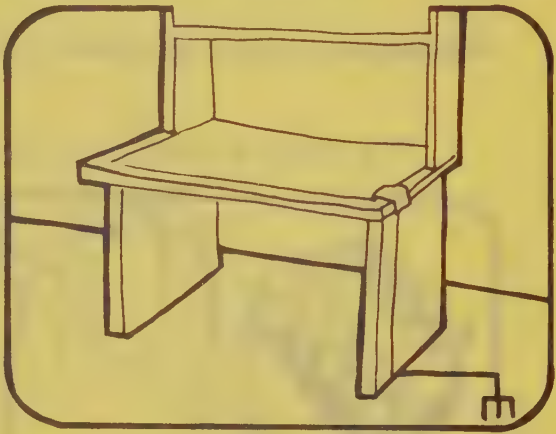
AND GENERAL DYNAMICS, POMONA DIV.



8. WHEN REMOVING PLUG-IN ASSEMBLIES, HANDLE ONLY BY NON-CONDUCTIVE EDGES AND NEVER TOUCH OPEN EDGE CONNECTOR EXCEPT AT STATIC-FREE WORK STATION. PLACING SHORTING STRIPS ON EDGE CONNECTOR USUALLY PROVIDES COMPLETE PROTECTION TO INSTALLED SS DEVICES.



9. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION

10. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.

11. ONLY GROUNDED TIP SOLDERING IRONS SHOULD BE USED.

Anti-static bags, for storing S.S. devices or pcbs with these devices on them, can be ordered from the John Fluke Mfg. Co., Inc.. See section 5 in any Fluke technical manual for ordering instructions. Use the following part numbers when ordering these special bags.

John Fluke Part No.	Description
453522	6″ X 8″ Bag
453530	8″ X 12″ Bag
453548	16″ X 24″ Bag
454025	12″ X 15″ Bag
Pink Poly Sheet 30″x60″x60 Mil P/N RC-AS-1200 $20.00	Wrist Strap P/N TL6-60 $7.00

® Dow Chemical

Section 4
Maintenance

WARNING!

THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

4-1. INTRODUCTION

4-2. This section of the manual contains maintenance information, performance tests, hardware calibration procedures, and troubleshooting procedures. Hardware calibration intervals may be determined by the user according to the accuracy desired (specifications are listed in Section 1). Software calibration may be performed at any time and is described in Appendix 7B. Recommended test equipment is listed in Table 4-1.

4-3. SERVICE INFORMATION

4-4. Each instrument manufactured by the John Fluke Mfg. Co., Inc. is warranted for a period of 1 year upon delivery to the original purchaser. The warranty terms are located at the front of the manual.

4-5. Factory authorized calibration and service for each Fluke product are available at various worldwide locations. A complete list of domestic service centers is located in Section 7 of the manual. Shipping information is given in Section 2. If requested, the customer will be provided an estimate before any work begins on instruments that are beyond the warranty period.

4-6. GENERAL MAINTENANCE

4-7. Top and Bottom Cover Removal and Installation

WARNING

LINE VOLTAGE IS PRESENT ON THE POWER SUPPLY BOARD WHENEVER THE POWER CORD IS CONNECTED. TO AVOID SHOCK HAZARD, DO NOT TOUCH POWER SUPPLY COMPONENTS.

4-8. Each cover is secured with six screws. When replacing a cover, install the rear center (pivot) screw first.

4-9. Line Voltage Selection

4-10. Input line voltage can be set for 100V ac, 120V ac, 220V ac or 240V ac. This selection must be made, or verified, before the multimeter is initially turned on. Proceed as follows:

1. Push the POWER control to OFF and disconnect the line cord

Table 4-1. Test Equipment

NOMENCLATURE	MINIMUM USE SPECIFICATIONS	RECOMMENDED EQUIPMENT
DC Source	High Short-Term Stability Range: 0-1100V	Fluke Model 335A
Null Detector	10 μV Full-Scale Resolution	Fluke Model 335A
Reference Divider	±.001% Division Accuracy	Fluke Model 750A
Kelvin-Varley Divider	Linearity: ±.1 PPM of Input	Fluke Model 720A
Standard Cell Enclosure	Guildline 91	Guildline 9152 (R)
Oscilloscope	General Purpose with 10 MΩ Probe	Tektronix 465
Digital Multimeter	Voltage Accuracy: .01% Input Impedance: 1000 MΩ	Fluke Model 8800A
Low EMF, Shielded Connector Cables	Gold-plated Spade Lug Connectors	
Terminating Load	1 MΩ ±10%/0.22 μf Nonpolarized Parallel Load	
Extender Card		Fluke Model MIS-7011K
Bus Monitor		Fluke Model MIS-7013K
Static Controller		Fluke Model MIS-7190K
Test Module		Fluke Model MIS-7191K
AS REQUIRED BY INSTALLED OPTIONS		
AC Calibration System	Voltage Range: 0-1000V ac Frequency Range: 10 Hz - 300 kHz Accuracy: 10 Hz - 30 Hz: .1% 30 Hz - 20 kHz: .02% 20 kHz - 100 kHz: .05% 100 kHz - 300 kHz: .33%	Fluke Model 5200A with Fluke Model 5215A or Fluke Model 5205A
Current Calibrator with 200 kΩ Resistor	Accuracy: ±.02% ±.01%	Fluke Model 382A
Standard Resistors	10Ω at 30 ppm; 100Ω, 1.9kΩ, 10kΩ, 100 kΩ, 250 kΩ, 1 MΩ, 4 MΩ at 10 ppm; 10 MΩ at 50 ppm; 100 MΩ at 100 ppm	ESI SR-1010 ESI SR-1050

2. Remove the multimeter top cover.

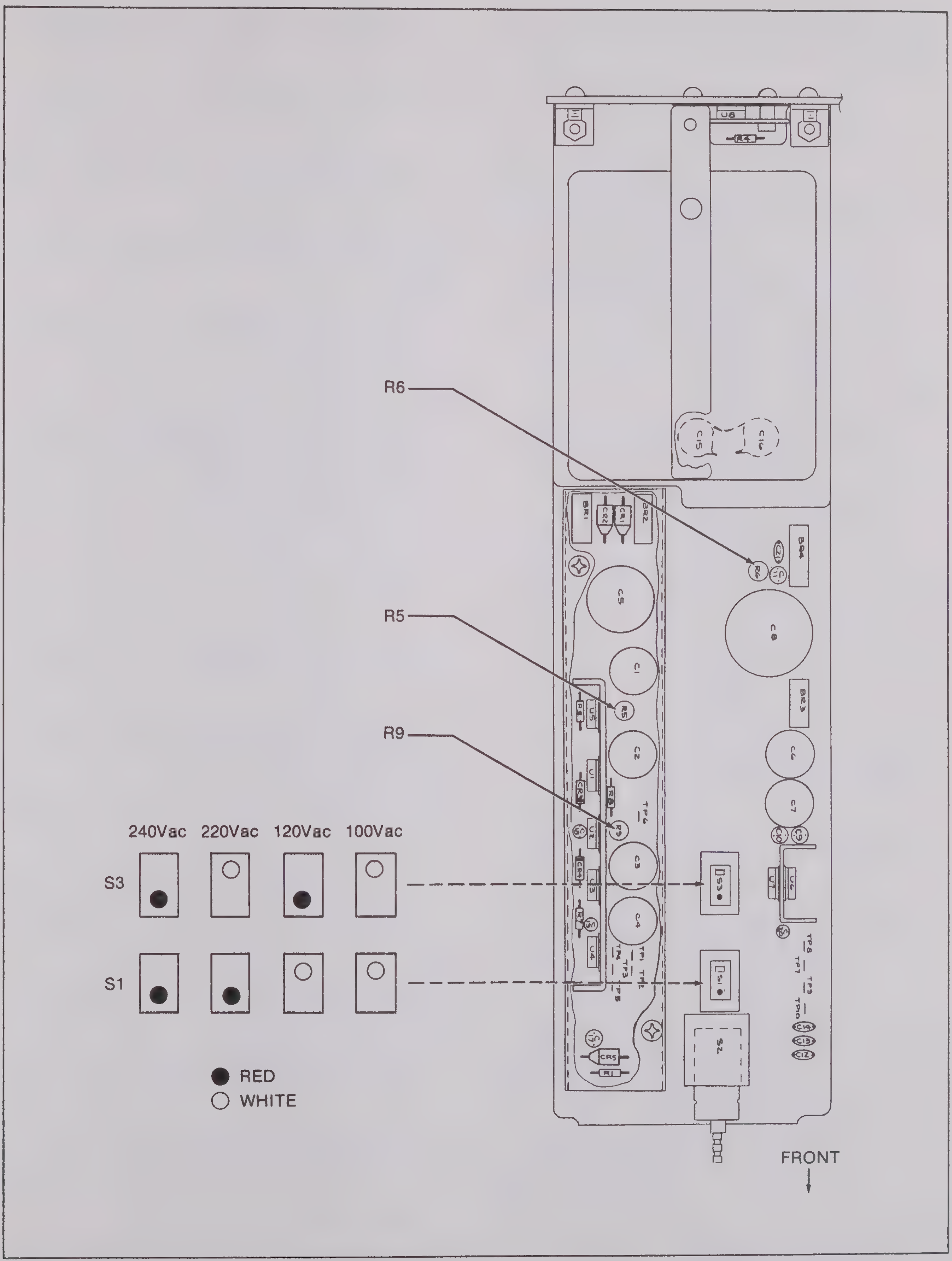
3. The Line Voltage Selection switches are located in the left front of the instrument, just behind the main power control. Referring to Figure 4-1, set these two switches to indicate the desired line voltage (dot/switch pattern).

4. Verify installation of the line power fuse required by the line selected voltage. With the line cord still disconnected, remove and inspect the line fuse (rear panel, near the heatsink). For 100V ac or 120V ac operation, use an MDL 1/2A fuse. For 220V ac or 240V ac operation, use an MDL 1/4A fuse.

5. If no further maintenance is necessary, install the top cover.

CAUTION

If the Calibration mode is enabled, input power must not be cycled on or off. Before cycling power off, verify that the AVG/(CAL) annunciator is not flashing. Before cycling power on, check that the rear panel Calibration Switch is off.


R6
R5
R9
S3
S1
FRONT
U8
R4
C15
C16
BR1
CR2
CR1
BR2
BR4
C5
C8
C1
BR3
C2
C6
C7
C3
C4
S2

	240Vac	220Vac	120Vac	100Vac
S3	●	○	●	○
S1	●	●	○	○

● RED
○ WHITE

Figure 4-1. Power Supply Settings

4-11. Fuse Replacement

4-12. The line fuse can be replaced using the following procedure:

1. On the multimeter front panel, push the POWER switch to OFF (out).
2. Disconnect the line power cord.
3. Locate the line fuse on the rear panel heat sink.
4. Identify the selected line voltage and replace the fuse with one having the appropriate ratings:

   MDL 1/2 (for 100 or 120V ac line)
   MDL 1/4 (for 220 or 240V ac line)
5. Reconnect the line power cord.
6. Push the POWER switch to ON.

4-13. Module Installation

CAUTION

Installation or removal of a module with the POWER switch ON can cause damage to sensitive circuitry. To avoid this kind of damage, push the POWER switch to OFF before installing or removing a module.

4-14. Use the following procedure for module installation.

1. Push the POWER Control to OFF and disconnect the line cord.
2. Remove the top cover.

NOTE

The multimeter allows some choice in the placement of modules. For example, the Ohms Converter (Option -02) may be placed in slot A, B, C, or D. But the A/D Converter only functions in slot H. The Isolator must be installed in slot K. A complete listing of preferred and permissible slots is offered in Section 8. Module slots are lettered from A through N as seen from front to rear.

3. With the correct slot chosen, slide the module down between the module guides.
4. Press the module firmly into place.
5. Open the hinged module top. Verify that the leaf spring (attached to one half of the module shield) is resting firmly over the flange of the opposite half of the module shield.
6. Close the module top and secure the module in position by engaging the two sliding clips.
7. Install the top cover.

4-15. Module Removal

4-16. Use the following procedure for module removal.

1. Push the POWER control to OFF and disconnect the line cord from the multimeter.
2. Remove the top cover.
3. Disengage the two sliding clips securing the module to be removed.
4. Grasp the module at both ends and pull up. Use an end-to-end rocking motion to help free the module from the connector.

4-17. Module Disassembly and Reassembly

4-18. Avoid using excessive force with the following procedure.

1. Pop open the lid on the module by using the indentations at either end and lifting up. Hinge the lid back.
2. Orient the module with one of the guides up.
3. Press down on the end of the case half above the words OPEN while pulling up lightly on the lip of the module guide. Slightly separate this end. Repeat this step for the other end.
4. Open the top of the module. The bottom catch automatically comes apart.
5. Press down on the top of the pcb while pulling out to free the pcb from the case half.
6. To reassemble the module, insert the pcb in the bottom half of the case and lightly press down on the top to snap it in place.
7. Ensuring that the spring shield connection is not caught behind the pcb, align the bottom center catch of the case halves and verify that the shield at either end fit together properly.
8. Close the two halves together, snapping the module guides closed.
9. Using a small screwdriver or similar tool, lift and position the leaf spring, attached to one half of the module shield, so that it rests firmly over the flange of the opposite half of the module shield.

4-19. Calibration Memory Replacement

4-20. Use the following procedure when replacing the Calibration Memory chip:

1. First ensure that the rear panel Calibration Switch is off, then push the POWER button to OFF and remove the line power cord.
2. Remove the top cover, then remove and disassemble the Controller module.
3. Install (or replace) the Calibration Memory chip (U20 on the Controller PCB).
4. Reassemble and install the Controller module, then replace the top cover.

5. Verify again that the Calibration Switch is off, then reconnect the line power cord and push the POWER button to ON.

6. Refer to Appendix 7B for Calibration Memory programming instructions.

4-21. Front Panel PCB Removal

4-22. Use the following procedure to remove the Front Panel PCB:

1. Note the position of any LEDs needing replacement. Push the POWER control to OFF and remove the line cord.

2. Remove the multimeter top cover (six screws).

3. Remove the front panel bezel. Press down on the bezel center top and pull out.

4. Remove the five screws securing the Front Panel PCB. Unplug this pcb by alternately pulling up gently on its upper corners. Once disconnected, work the pcb forward to clear the power push button, then retract it through the front opening.

5. If necessary, replace any defective LEDs.

6. Replace the Front Panel PCB and the bezel in the reverse order.

4-23. Power Supply Removal

4-24. Remove the Power Supply PCB Assembly using the following procedure:

1. Push the POWER button to OFF and disconnect the line power cord from the multimeter.

2. Remove the three buttonhead screws attaching the Power Supply to the rear panel. As seen from the rear, one of these screws is found along the Power Supply left edge; the other two secure both the feet and the Power Supply right edge.

3. Pulling from the rear, retract the Power Supply PCB with a gentle rocking motion. Once disconnected from the card edge connector at the front, the pcb slides straight back.

4. Replace the Power Supply PCB by reversing the steps above. The left center buttonhead screw also serves as a ground connection between the Power Supply and the multimeter chassis. Tighten this screw securely.

4-25. Power Supply Interconnect PCB Removal

4-26. Remove the Power Supply Interconnect PCB using the following procedure:

1. Remove the Front Panel and Power Supply.

2. Remove the three screws securing the Power Supply Interconnect PCB to the framework.

3. Disconnect the card edge connector of the pcb from the Motherboard connector. Lift the pcb out through the front framework.

4. Reassemble in the reverse order.

4-27. Front/Rear Switch Assembly

4-28. REMOVAL

4-29. Use the following procedure to remove the Front/Rear Switch Assembly:

1. Push the POWER control to OFF and disconnect the line cord from the multimeter.

2. Remove the multimeter top cover.

NOTE

As seen from the front, the Front/Rear Switch Assembly is housed in the right side chassis. Although the Front/Rear Switch Assembly is mechanically secured to the vertically aligned rear panel, it is electrically connected to the horizontally aligned Motherboard PCB. Removal and replacement of the Front/Rear Switch Assembly each require a unique procedure.

3. At the front panel right side, pull on the three selector buttons until they disconnect from the Front/Rear Switch Assembly.

4. Remove the three buttonhead screws securing the Front/Rear Switch Assembly to the rear panel. Identify two of these screws as also attaching two of the rear panel feet.

5. Next, remove the three screws securing the assembly front-to-back along the right side.

6. The assembly must now be disengaged from the Motherboard PCB edge connector. Viewing the multimeter from the front, locate a slot in the chassis behind the Front Panel PCB (upper right side). A tab on the Front/Rear Switch PCB extends through this slot. Pry upward on this pcb tab to disengage the Front/Rear Switch Assembly from its Motherboard connector.

7. Once disconnected, the Front/Rear Switch Assembly can be withdrawn straight back.

4-30. REPLACEMENT

4-31. Use the following procedure to replace the Front/Rear Switch Assembly:

1. Replacement requires that the assembly be positioned in the rear panel slot and slid forward.

The pcb tab mentioned above must be inserted far enough into the front chassis slot so that the assembly rests flush against the rear panel.

2. The Front/Rear Switch Assembly is now aligned with the Motherboard edge connector. Push the assembly into this connector by simultaneously pressing on the center of the Front/Rear Switch PCB (through an access hole in the middle of the right side chassis) and on the pcb tab.

3. Replace the three side screws and the three rear panel buttonhead screws (with feet).

4. On the Front Panel right side, insert each of the three selector buttons through slots in the front panel and in the right side chassis. Align each button with the appropriate switch and press into place. The three selector buttons must be configured as follows:

   a. EXT GD IN: top

   b. 4T OHMS IN: middle

   c. REAR INPUT IN: bottom

4-32. Motherboard PCB Removal

4-33. Remove the Motherboard PCB using the following procedure:

1. Push the POWER button to OFF and disconnect the power cord from the multimeter.

2. Remove the top and bottom covers.

3. Remove all modules, the Front Panel PCB, the Power Supply PCB, the Front/Rear Switch Assembly, and the Power Supply Interconnect PCB.

4. Remove the shield covering the bottom of the Motherboard. Remove the eight securing screws (accessed from the bottom) and the two top screws (accessed through holes in the center partition). The shield then slips off.

5. As seen from the top, unplug the SCAN ADV and TRIGGER connectors from the right rear corner of the Motherboard.

6. Remove the eight screws securing the Motherboard PCB (four each accessed from top and bottom).

7. Remove the front handle-frame assembly. Remove the three screws attaching each handle. Note that the longest screws must occupy the center holes during reassembly.

8. Pull off the front handle-frame assembly.

9. The Motherboard PCB is now disconnected and can be removed.

10. Replace the Motherboard PCB and reassemble the multimeter in reverse order.

4-34. Cleaning Instructions

4-35. Periodically (at least every 90 days) clean the multimeter using the following procedure:

1. Push the POWER switch to OFF and disconnect the power cord from the multimeter.

2. Remove the top and bottom covers from the instrument.

3. Disconnect the modules from the Motherboard and remove them from the instrument.

4. Clean the interior using low pressure clean, dry air or a vacuum cleaner.

5. Clean the Front Panel and exterior surfaces with anhydrous ethyl alcohol or a soft cloth dampened with a mild solution of detergent and water.

6. Replace the modules and covers if access to the instrument interior is no longer required.

4-36. PERFORMANCE TEST

4-37. Introduction

4-38. The following paragraphs contain a performance verification test which compares the operation of the instrument to the specifications in Section 1 of this manual. The test may be used to verify calibration of the equipment between scheduled calibration periods or as an aid in troubleshooting. The multimeter will be referred to as unit under test (UUT). The test equipment required for the Performance Test is listed in Table 4-1. If the recommended equipment is not available, replacements with equivalent specifications may be substituted.

4-39. If the instrument does not meet the specifications listed in the Performance Test, either software or hardware calibration or corrective maintenance should be performed, as determined by the symptoms. The test should be performed when the ambient temperature is between 18° and 28° Celsius and the relative humidity less than 75% to maintain test validity.

4-40. Low Range DC Voltage Tests

4-41. Perform the Low Range Tests as follows:

1. Connect the equipment shown with solid lines in Figure 4-2. Do not connect the UUT at this time.

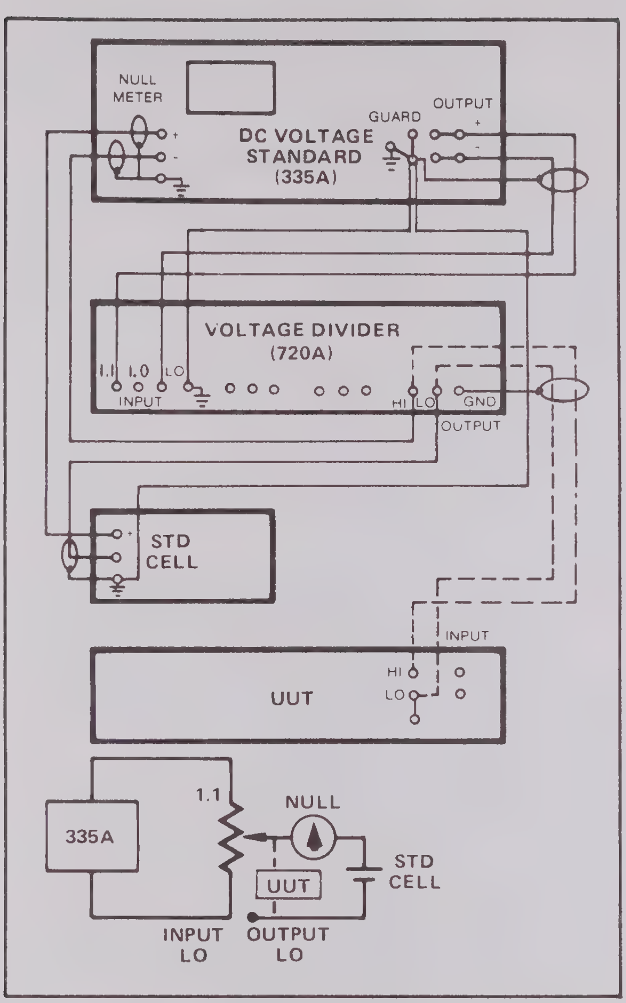

NULL
METER
GUARD
OUTPUT
+
-
DC VOLTAGE
STANDARD
(335A)
VOLTAGE DIVIDER
(720A)
1.1
1.0
LO
INPUT
HI
LO
GND
OUTPUT
+
STD
CELL
INPUT
HI
LO
UUT
335A
1.1
NULL
UUT
STD
CELL
INPUT
LO
OUTPUT
LO

Figure 4-2. Connections for Low Range DC Voltage Tests

2. Verify that test equipment used in Figure 4-2 is operating properly and that respective warmup periods have been observed.

3. On the UUT, verify that the specified two-hour warm-up period has elapsed.

4. On the UUT, select the following features: VDC function, AUTO range, SAMPLE setting 5. All other features should be in the power-up configuration.

5. Set the Voltage Divider controls for one-tenth the standard cell certified value. Adjust the DC Voltage Standard output for a null on the null meter.

6. At the Voltage Divider output terminals, disconnect the existing leads and connect the UUT as shown with the broken lines in Figure 4-2.

7. Refer to Table 4-2. Without changing the DC Voltage Standard output setting, perform the six checks listed. For each check, set the specified Voltage Divider output, select the listed UUT range manually, and verify a UUT reading with the tolerances listed.

Table 4-2. Low Range DC Voltage Tests

RANGE	DIVIDER SETTING	UUT READING	
		LOW	HIGH
100 mV	.0010000	+9.9947 (-3)	+10.0053 (-3)
100 mV	.0100000	+99.9920 (-3)	+100.0080 (-3)
1 V	.0100000	+.099990	+.100010
1 V	.1000000	+.999972	+1.000028
10 V	.1000000	+.99991	+1.00009
10 V	1.0000000	+9.99982	+10.00018

8. At the DC Voltage Standard, reverse the output leads. Now repeat step (7), and check for negative UUT readings with the listed tolerances.

4-42. High Range DC Voltage Tests

4-43. Perform the High Range Test as follows:

1. Connect test equipment and the UUT as shown in Figure 4-3.

2. On the UUT, verify that the specified two-hour warm-up period has expired. Also verify that the test equipment is operating properly and that required warm-up periods have expired.

3. The UUT must be set for dc volts, 100V range (manual), and SAMPLE setting 5. All other features on the UUT must be in the power-up configuration.

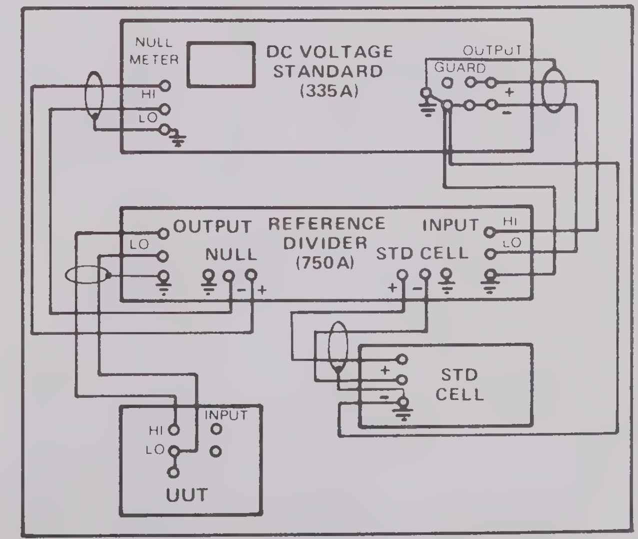

NULL
METER
HI
LO
DC VOLTAGE
STANDARD
(335A)
OUTPUT
GUARD
+
-
OUTPUT
LO
NULL
REFERENCE
DIVIDER
(750A)
INPUT
HI
LO
STD CELL
+
-
STD
CELL
INPUT
HI
LO
UUT

Figure 4-3. Connections for High Range DC Voltage Tests

4. On the Reference Divider, set the Standard Cell voltage controls to the standard cell certified value. Set both the input and output controls to 10 volts.

5. On the DC Voltage Standard, set the output controls for 10 volts. Next adjust this output for a null reading on the null meter.

6. On the UUT, verify a reading between +9.9990 and +10.0010.

7. On the Reference Divider, set the input and output controls to 100 volts.

8. On the DC Voltage Standard, set the output controls for 100 volts. Next, adjust this output for a null reading on the null meter.

9. On the UUT, verify a reading between +99.9974 and +100.0026.

10. On the UUT, manually select 1000V range.

11. On the UUT, verify a reading between +99.990 and +100.010.

12. On the Reference Divider, set the input and output controls to 1000 volts.

13. On the DC Voltage Standard, set the output to approximately 1000V. Next adjust this output for a null reading on the null meter.

14. On the UUT, verify a reading between +999.974 and +1000.026.

15. Set the DC Voltage Standard to standby.

Table 4-3. Autoranging

UUT CHANGES RANGE		APPROXIMATE READING
FROM	TO	
100 mV	1V	200 mV
1V	10V	2.0V
10V	100V	20V
100V	1000V	128V
1000V	100V	120V
100V	10V	12V
10V	1V	1.7V
1V	100 mV	0.17V

16. Reverse the leads at the DC Voltage Standard and at the Standard Cell terminals. In sequence, set the DC Voltage Standard output to 10 volts, and return this instrument to operate.

17. On the UUT, manually select the 10V range.

18. Now repeat steps (4) through (15), verifying negative readings on the UUT.

4-44. Autoranging Test

4-45. Test the UUT autoranging feature using the following procedure:

1. On the UUT, select V DC function and AUTO range.

2. Connect the DC Voltage Standard output directly to the UUT input.

3. Vary the DC Voltage Standard output, checking that the UUT autoranges up and down at the points listed in Table 4-3. These points are approximate and are determined without application of software calibration factors.

4-46. DC External Reference Test

4-47. Test the DC four-wire true ratio, using the following procedure:

1. Connect test equipment and the UUT as illustrated in Figure 4-4.

2. On the UUT, select V DC function and AUTO range.

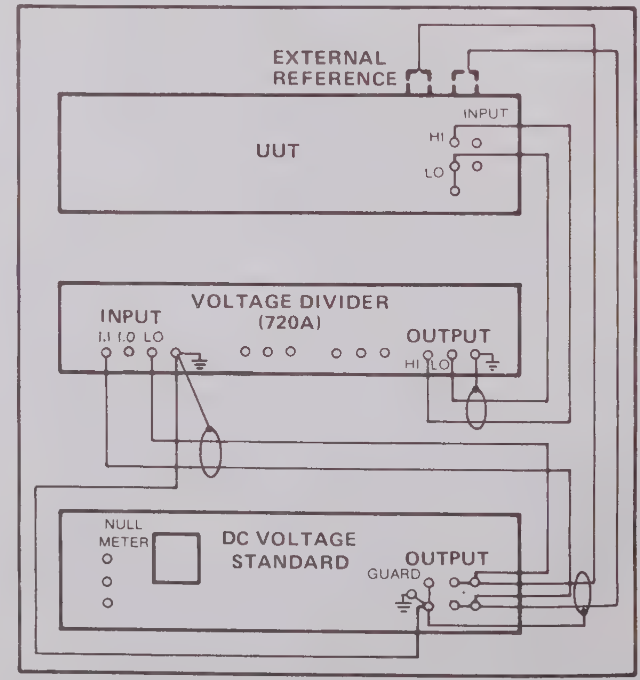


Figure 4-4. DC External Reference Test

3. On the DC Voltage Standard, set the output controls for +10.0000 volts.

4. On the Voltage Divider, set the controls for 1.000000.

5. On the UUT, push and hold the EXT REF button. Verify a reading of +9.99962 to +10.00038 while this button is held depressed.

6. Release the EXT REF push button on the UUT (EXT annunciator on). The UUT now computes and displays the ratio (Vin/Vref). Verify that this reading is between 0.999944 and 1.000056 ±(40 ppm + 16 digits).

7. On the Voltage Divider, set the controls to 0.1000000.

8. Verify that the UUT reads between 99.9939(-3) and 100.0061(-3) ±(45 ppm + 16 digits).

9. Push and release the EXT REF button to toggle the UUT out of External Reference mode (EXT annunciator goes off).

10. Remove the test equipment connections. This step completes the Performance Test procedures.

4-48. CALIBRATION ADJUSTMENTS

NOTE

The standards called out in the following procedure are required to meet the published accuracy specifications. If published accuracy is not required for a particular function (e.g. Resistance, DC Current, etc), standards with a lower rated accuracy may be used.

4-49. Introduction

4-50. Calibration of the UUT is carried out on three levels. The first level consists of an accuracy check using the Performance Test. The Performance Test should be used to check the UUT for calibration every 90 days or 1 year, as required to meet the applicable accuracy specifications. The Performance Test should also be used to check the UUT for calibration after any repairs are made to the instrument. The second level involves software calibration and can be performed at any time. Applicable procedures are described in Appendix 7B. The third level involves hardware calibration and is described in the following paragraphs. Power supply adjustments are shown in Figure 4-1. Adjustments and test points are accessible on the top edge of the pcb by opening the hinged module top. For any level of calibration, the ambient temperature should be 23°C ± 2°C and the relative humidity should be less than 75%. Refer to Table 4-1 for the recommended test equipment.

4-51. Initial Procedure

4-52. With the POWER switch set to OFF, replace the Isolator with the Bus Interconnect and Monitor Board (MIS-7013K). Set the POWER switch to ON and allow the instrument to warm up for at least 2 hours before continuing with the calibration adjustment procedures.

4-53. DC Calibration Procedure

4-54. Hardware calibration is described in this section. If the Calibration Memory contains dc volts calibration entries, the following clearing procedures must first be used:

1. Select VDC function and 100 mV range.

2. Toggle the ZERO VDC/OHMS button so that the ZERO annunciator goes dark.

3. Slide the rear panel Calibration Switch to the on position and verify that the AVG/(CAL) annunciator is flashing.

4. For each range, push STORE (CAL COR). This operation disables software calibration factors for the VDC function.

4-55. Ensure that the selectors on the front panel (right) are positioned as follows:

1. Guard Selector - disengaged (out - internal guard)

2. Ohms Selector - engaged (in - 4T)

3. Rear Input Selector - disengaged (out - front inputs)

4-56. POWER SUPPLY

4-57. Perform the following Power Supply checks and adjustments. All required test points are available on the Bus Interconnect and Monitor Board. All adjustments are found on the Power Supply Board, as illustrated in Figure 4-1.

CAUTION

The multimeter can be damaged if used to check its own supply voltage. To avoid this possibility, do not use the UUT to check UUT voltages.

1. Connect the test DMM HI input to Vcc on the Bus Interconnect and Monitor Board and the LO input to Vss.

2. Adjust R6 for a reading of 5.05V dc ± .05 to set the logic supply.

3. Transfer the HI DMM input lead to VA2.

4. Adjust R5 for a reading of 5.05V dc ± .05 to set the analog supply.

5. Verify that the voltages in Table 4-4 are within the prescribed limits.

6. Prepare the test DMM to read ac volts. Connect the HI DMM input lead to LINE on the Bus Interconnect and Monitor Board (LO to AR). If the UUT is set for 100V ac or 120V ac operation, verify a voltage reading of 13 to 17V ac. With 220V ac or 240V ac operation, verify a voltage between 6.5V ac and 8.5V ac.

Table 4-4. Power Supply Verifications

TEST POINTS		VOLTAGE RANGE (VDC)		SUPPLY
HIGH	LOW	FROM	TO	
VDD	Vss	+11.4	+12.6	Logic
VGG	Vss	-11.4	-12.6	Logic
VA1	AR	+14.25	+15.75	Analog
VA2	AR	-14.25	-15.75	Analog
VA3	AR	+29.7	+31.7	Analog
VA4	AR	-29.7	-31.7	Analog

7. On the UUT, push the POWER button to OFF, remove all test leads and the Bus Interconnect and Monitor Board, and replace the Isolator.

8. Reapply power to the UUT.

4-58. DC SIGNAL CONDITIONER ADJUSTMENTS

4-59. All adjustments in the following procedure are on the DC Signal Conditioner.

1. Select dc volts, 100 mV range, slow filter (toggle FILTER until the FILTER annunciator lights), sample 7 (toggle SAMPLE until the SAMPLE annunciator flashes slowly), Calibration switch ON (AVG/CAL annunciator flashes), and V DC/Ohms Zero off (ZERO annunciator off).

2. Place a short across the VOLTS INPUT/OHMS SENSE HI and LO terminals.

3. Adjust R53 for a UUT reading of 0.0000 ± .0002 (-3).

4. Remove the short from the input terminals. Place a 1 megohm resistor in parallel with a 0.22 uF capacitor across VOLTS INPUT/OHMS SENSE HI and LO terminals.

5. Adjust R52 for a UUT reading of 0.0000 ± .0030 (-3).

6. Repeat steps (2) through (5) until both readings are within range without further adjustment.

4-60. A/D CONVERTER CALIBRATION PROCEDURES

4-61. Use the following procedure to calibrate the A/D Converter module. All adjustments and test points mentioned in this procedure are found on the A/D Converter module. References are found at the top of the A/D Converter pcb or on the inside of the hinged module top. Only the hinged module top need be opened to access these test points and adjustments.

4-62. This paragraph contains the adjustment procedure for R64. This resistor requires adjustment only if R54 in the tens bit ladder has been replaced during repair. If no such replacement has been made, proceed to the next paragraph.

1. Connect a test DMM HI input to TP7, LO input to TP6.

2 Adjust R1 for a test DMM reading of -7.0000V ± .0002V.

3. Remove the test DMM connections.

4. Set the UUT for the 10V range.

5. Using the test connections in Figure 4-2, apply 10.100000V dc to the UUT input terminals.

6. On the UUT, adjust R64 for a reading of +10.100000 ± .000050.

7. Remove the test connections and proceed with the following adjustments.

4-63. A/D Zero Adjustment

4-64. Use the following steps to adjust auto zero on the A/D Converter module:

1. Verify that the 10V range is set on the UUT.

2. Short the UUT input terminals.

3. On the UUT, adjust R8 for a reading of 0.00000 ± .00001.

4-65. Control Setting A

4-66. To prepare the DC Voltage Standard for subsequent tests and adjustments, use the following procedure:

1. Connect test equipment as shown in Figure 4-2. Make only the connections shown as solid lines; the UUT is not connected at this time.

2. Set the Voltage Divider controls at one-tenth the standard cell certified value (standard cell value X 0.1).

3. Adjust the DC Voltage Standard output for a null on the null meter.

4. Record the dial setting of the DC Voltage Standard as Control Setting A. This value will be used later in the A/D Converter Calibration Procedures.

5. Disconnect the two leads at the Voltage Divider output terminals. Connect the UUT as shown in Figure 4-2 (broken lines).

4-67. A/D Ladder Adjustments

4-68. Use the following procedure when adjusting the A/D Ladder:

1. Verify that the UUT is set for the 10V range.

2. Set the Voltage Divider controls for a ratio of 1.0100000.

3. On the UUT, adjust R1 (POS. CAL) for a reading of +10.10000V ± .00001.

4. On the DC Voltage Standard, reverse the dc voltage polarity.

5. On the UUT, adjust R2 (NEG. CAL) for -10.10000V ± .00001. If the R1 and R2 adjustments cannot be made, perform the A/D Converter Calibration Procedures.

6. On the DC Voltage Standard, restore the positive dc voltage output polarity.

7. Set the Voltage Divider controls for a ratio of 0.0500000.

8. On the UUT, adjust R7 (REMAINDER) for a front panel display of +0.50000 ± .00001.

9. Repeat steps (2) through (8) until all readings are within tolerance without making further adjustments.

10. Set the Voltage Divider controls for a ratio of 0.5100000.

11. On the UUT, adjust R6 (5V LADDER) for a reading of +5.10000 ± .00001.

12. Set the Voltage Divider controls for a ratio of 0.2600000.

13. On the UUT, adjust R5 (2.5V LADDER) for a reading of +2.60000 ± .00001.

14. Set the Voltage Divider controls for a ratio of 0.1400000.

15. On the UUT, adjust R4 (1.25V LADDER) for a reading of +1.40000 ± .00001.

16. Set the Voltage Divider controls for a ratio of 0.0750000.

17. On the UUT, adjust R3 (.625V LADDER) for a reading of 0.75000 ± .00001.

18. Repeat steps 2 through 17 until all steps are within the stated tolerance.

4-69. LINEARITY VERIFICATION

4-70. Use the following procedure to check linearity for the UUT:

1. Verify that the UUT is set for the 10V range (manual) and sample setting 7.

2. Set the Voltage Divider controls for a ratio of 0.2000000.

3. Set the DC Voltage Standard for an output of approximately 100V. Adjust this output for a reading on the UUT of +20.00000 ±.00012.

4. Set the Voltage Divider controls for a ratio of 0.0000000 and verify that the UUT reading is 0.00000 ± .00001.

5. Reverse the polarity of the dc output voltage at the DC Voltage Standard.

6. On the UUT, verify a reading of -0.00000 ± .00001.

7. At the DC Voltage Standard, restore the dc output voltage positive polarity.

8. Refer to Table 4-5. For each of the Voltage Divider settings listed, verify a UUT reading within the listed tolerances.

Table 4-5. Linearity Checks

DIVIDER SETTING	READINGS		
	MINIMUM	NOMINAL	MAXIMUM
.0100000	0.99995	1.00000	1.00005
.0200000	1.99995	2.00000	2.00005
.0300000	2.99995	3.00000	3.00005
.0400000	3.99995	4.00000	4.00005
.0500000	4.99995	5.00000	5.00005
.0600000	5.99995	6.00000	6.00005
.0700000	6.99995	7.00000	7.00005
.0800000	7.99995	8.00000	8.00005
.0900000	8.99995	9.00000	9.00005
.1000000	9.99995	10.00000	10.00005
.1100000	10.99994	11.00000	11.00006
.1200000	11.99994	12.00000	12.00006
.1300000	12.99994	13.00000	13.00006
.1400000	13.99993	14.00000	14.00007
.1500000	14.99993	15.00000	15.00007
.1600000	15.99993	16.00000	16.00007
.1700000	16.99992	17.00000	17.00008
.1800000	17.99992	18.00000	18.00008
.1900000	18.99992	19.00000	19.00008
.2000000	19.99992	20.00000	20.00008

9. At the DC Voltage Standard, reverse the polarity of the dc output voltage. For each of the Voltage Divider settings in Table 4-5, verify a negative UUT reading within the listed tolerances.

10. At the DC Voltage Standard, restore positive polarity and adjust for Control Setting A.

11. Set the Voltage Divider controls for a ratio of 1.0000000.

12. On the UUT, verify a reading of +10.00000 ± .00001.

4-71. RANGE ADJUSTMENTS

4-72. All adjustments and test points in the following procedure are found on the DC Signal Conditioner. References mentioned in this procedure can be typically found on the top edge of the DC Signal Conditioner PCB and on the inside of the hinged module top. Only the hinged module top need be opened to access all adjustments and test points.

4-73. Use the following steps to adjust the 100 mV range:

1. Verify that the UUT is set for dc volts, FILTER annunciator off, sample setting 7, and ZERO annunciator off.

2. Verify that the DC Voltage Standard is set for Control Setting A.

3. Set the Voltage Divider controls for a ratio of .0000000.

4. On the UUT, manually select the 100 mV range. If required adjust R53 for 0 ± .0002 (-3).

5. Set the Voltage Divider controls for a ratio of .0200000.

6. On the UUT, adjust R49 for a front panel display of +200.0000 (-3) ± .0005.

4-74. Use the following procedure to adjust the 1V range:

1. On the UUT, select the 1V range.

2. Set the Voltage Divider controls for ratio of .20000000.

3. On the UUT, adjust R48 for a front panel display of +2.000000 ± .000001.

4-75. Use the following procedure to check the 10V range:

1. On the UUT, select the 10V range.

2. Connect the UUT directly to the DC Voltage Standard as shown in Figure 4-2.

3. On the DC Voltage Standard, set the output to Control Setting A.

4. On the UUT, verify a front panel display of +10.00000 ± .00002V.

4-76. Use the following procedure to adjust the 100V range:

1. Connect the equipment as shown in Figure 4-3.

2. On the UUT, select the 100V range.

3. On the Reference Divider, set the standard cell voltage controls to the standard cell certified value and both the input and output controls to 100V.

4. On the DC Voltage Standard, set the output to approximately 100.0000V and adjust for a null on the null meter.

5. On the UUT, adjust R47 for a front panel display of +100.0000 ± .0001V.

4-77. Use the following procedure to check the 1000V range:

1. On the UUT, select the 1000V range and slide the rear panel Calibration switch to OFF. Verify that the AVG/(CAL) annunciator is off.

2. Verify that the 100 volt setting on the Reference Divider is still nulled.

3. Verify a UUT reading of 100.000 ± .005.

4. Set the Reference Divider input and output controls to 500 volts.

5. Set the DC Voltage Standard to approximately 500 volts, then adjust its output for a null on the null meter.

6. The UUT should read 500.000 ± .010.

7. Set the Reference Divider input and output controls to 1000 volts.

8. Set the DC Voltage Standard to approximately 1000 volts, then adjust its output for a null on the null meter.

9. The UUT should read 1000.000 ± .014.

4-78. If no further hardware calibration is necessary, verify that the Calibration mode is disabled (rear panel switch off). Refer to Appendix 7B for software calibration procedures.

4-79. TROUBLESHOOTING

4-80. Static discharge can damage components contained in the UUT. The following precautions should be observed during troubleshooting, repair, or module replacement.

1. Never connect or disconnect modules or components without first pushing the UUT Power switch to OFF.

2. Perform all repairs at a static-free work station.

3. Minimize handling of ICs and pcb's; do not handle them by their connectors.

4. Keep repair parts in their original containers until ready for use.

5. Use static ground straps to discharge repair personnel.

6. Use conductive foam or anti-static containers to store replacement or removed ICs and pcb's

7. Remove all plastic, vinyl, and styrofoam products from the work area.

8. Do not slide static-sensitive devices over any surface.

9. Use only anti-static type solder removal tools.

10. Use grounded tip soldering irons.

4-81. A procedure for isolating faulty modules is contained in Table 4-6. It is important that the theory of operation given in Secton 3 be read before attemping to troubleshoot the UUT. The module isolation procedure involves making observation of the UUT behavior, then removing or replacing modules to establish cause-effect relationships. Do not remove or replace modules with the power on. Follow the procedure step by step all the way through to assure that the fault is isolated to the correct module. Faults in some modules may cause apparent faults in other modules.

WARNING

A HAZARDOUS COMMON MODE VOLTAGE MAY APPEAR ON THE OUTPUT CONNECTOR OF THE BIT SERIAL REMOTE INTERFACE IF THE BUS INTERCONNECT MONITOR BOARD IS INSTALLED AS A REPLACEMENT FOR THE ISOLATOR. TO AVOID THIS SHOCK HAZARD, REMOVE THE BIT SERIAL REMOTE INTERFACE BEFORE INSTALLING THE BUS INTERCONNECT MONITOR BOARD.

4-82. Figure 4-5 and Tables 4-6 through 4-11 contain symptom analysis troubleshooting information for each of the modules and pcb's contained in the mainframe. The possible failures are listed in order of probability. Troubleshooting information for optional modules is contained in Section 6.

GUARDED SUPPLY

SYMPTOM	POSSIBLE FAILURE
VA1 — BAD	U3,BR2, or Transformer
(+15V). Noisy	C3
VA2 — BAD	U4,BR2, or Transformer
(-15V) Noisy	C4
VA3 — BAD	U1,CR3,BR1, Transformer
(+30V) Noisy	C1
VA4 — BAD	U2,CR4,BR1, Transformer
(-30V) Noisy	C2
V_{CC} (Guarded)	U5,R5,R3,C5,CR1,CR2, Transformer

VA1 and VA2 are used as a reference for VA3 and VA4. VA3 and VA4 could load down VA1 and VA2. Check by lifting the reference diodes CR3 and CR4.

UNGUARDED SUPPLY

V_{DD} (+12V)	U6,C6,C9,C12,BR3, Transformer
V_{GG} (-12V)	U7,C13,C10,C7,BR3, Transformer
V_{CC} (+5V)	U8,R6,R4,C8,C14,C11,BR4, Transformer

The drawing below identifies test points on the Power Supply pcb. Input voltages to the regulators should be approximately 5V higher than the normal output voltages. If the output is higher or lower than specified and noise is not the problem, the regulator is bad.

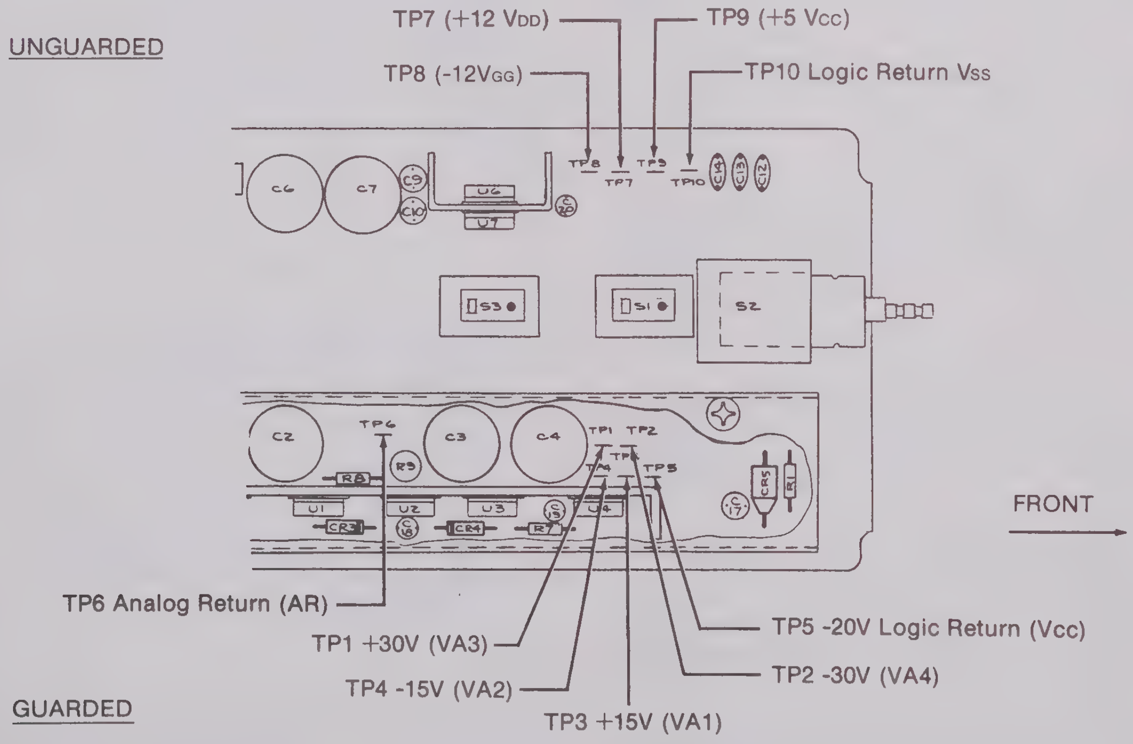

TP7 (+12 VDD)
TP9 (+5 Vcc)
UNGUARDED
TP8 (-12VGG)
TP10 Logic Return Vss
C6
C7
C9
C10
U6
U7
C20
TP8
TP7
TP9
TP10
C14
C13
C12
S3
S1
S2
C2
TP6
C3
C4
TP1
TP2
TP3
TP4
TP5
R8
R9
U1
U2
U3
U4
CR3
C18
CR4
R7
C19
CR5
R1
C17
FRONT
TP6 Analog Return (AR)
TP1 +30V (VA3)
TP4 -15V (VA2)
TP3 +15V (VA1)
TP5 -20V Logic Return (Vcc)
TP2 -30V (VA4)
GUARDED

Figure 4-5. Power Supply Troubleshooting

Table 4-6. Faulty Module Isolation

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1.	Turn the power ON. The following should be displayed: HI-Y.Y.Y.(Y=Program number) then CXXXXXX (X = installed option number) then 0.000 (±.050 DC Volts, 1000V range, fast sample rate)		
2.	Is the display blank	6	3
3.	Is the initial display other than HI-Y.Y.Y.	42	4
4.	Is the reading other than 0.000 ±.050	59	5
5.	Are the first three displays normal?	78	2
	DISPLAY BLANK AT POWER ON		
6.	Remove Bus Interconnect (or Isolator if installed).		
7.	Turn power ON. Is HI-Y.Y.Y. displayed?	8	11
8.	Was the isolator installed?	9	11
9.	Install interconnect-monitor in the Isolator slot. Is HI-Y.Y.Y displayed?	10	13
10.	Bad Isolator. Go to Section 6 under Isolator.		
11.	Is the power indicator on?	17	12
12.	Check the fuse. Is it bad (replace)?	1	17
13.	Remove Cal Memory and remote interfaces if installed. Is HI-Y.Y.Y. displayed?	14	17
14.	Replace Cal Memory, is HI-Y.Y.Y. displayed?	16	15
15.	Bad Cal Memory.		
16.	Bad Remote Interface.		
17.	Install the Interconnect-Monitor PCB in the Isolator slot.		
18.	Check power supply voltages as follows. Test DMM Common to VSS. VDD = +11.4 to +12.6 VGG = -11.4 to -12.6 6.5V ac to 8.5V ac VCC = +5.15 to 5.25 LINE = 13V ac to 17V ac (at 100 or 120V ac), or 6.5V ac to 8.5V ac (at 220 or 240V ac)		
19.	Are the power supplies within tolerance?	26	20
20.	Remove all modules except the Front Panel.		
21.	Recheck power supplies. Within tolerance?	22	23
22.	Replace modules one at a time (start with Controller), rechecking supplies after replacing each module. The last one put in when the supplies go bad is the problem. Go to the appropriate figure for that module.		
23.	Remove the front panel. Recheck supplies. Within tolerance?	25	24

Table 4-6. Faulty Module Isolation (cont)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
24.	Problem on power supply, motherboard, or power supply interconnect.		
25.	Bad Front Panel. Go to Figure 4-7.		
26.	Remove Cal Memory and the remote interface if installed.		
27.	Check IC 6, 5, 1, 0 on interbus. All moving?	28	30
28.	Check ACK line. Moving?	29	30
29.	Check ID0-7. All moving?	32	30
30.	Check Controller Sync Pulse at TP7. Moving?	33	31
31.	Bad Controller. Go to Figure 4-6.		
32.	Bad Front Panel. Go to Figure 4-7.		
33.	Remove analog modules, leaving only Controller, Front Panel, and Interconnect. Is the display normal?	34	35
34.	Faulty Analog Module. Replace one at a time — last one in is the problem. Go to the appropriate figure for that module.		
35.	Remove Front Panel, replace DC Signal Conditioner, Filter, A/D Converter.		
36.	Check IC lines, ACK line, ID lines. All moving?	38	37
37.	Bad Controller. Go to Figure 4-6.		
38.	Bad Front Panel. Go to Figure 4-7.		
	INITIAL DISPLAY OTHER THAN (HI-Y.Y.Y.)		
39.	Remove Interconnect PCB (or Isolator if installed).		
40.	Apply power. Is the display as follows? HI- Y.Y.Y. CXXXXXX Error 9	41	44
41.	Was the Isolator installed?	42	47
42.	Install Interconnect-Monitor PCB in Isolator slot. Is display normal?	43	48
43.	Bad Isolator. Go to Section 6.		
44.	Are Cal Memory or remote interface installed?	45	47
45.	Remove Cal Memory and remote. Display normal?	46	47
46.	Replace one at a time. Go to appropriate figure.		
47.	Install Interconnect-Monitor PCB.		
48.	Check for shorts between the IC and the ID lines. Shorts?	49	51
49.	Remove all modules except Front Panel. Removed short?	50	57

Table 4-6. Faulty Module Isolation (cont)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
50.	Reinstall modules one at a time (start with Controller), checking for shorts between modules. Last one in is the problem. Go to the figure for the appropriate module.		
51.	Are any of the IC, ID, or ACK lines always high or always low?	53	52
52.	Remove all modules except Front Panel and Controller. IC and ID moving?	56	53
53.	Remove Front Panel. Reinstall dc analog modules if removed.		
54.	Are the IC, ID, and ACK lines moving?	57	55
55.	Bad Controller. Go to Figure 4-6.		
56.	Is the display normal?	58	57
57.	Front Panel bad. Go to Figure 4-7.		
58.	Faulty Analog module. Replace one at a time until symptoms recur. Last one in is faulty. Go to the figure for the appropriate module.		
	READING NOT ZERO AT TURN ON		
59.	Remove all optional modules (except Isolator if installed), leaving Controller, (Isolator), DC Signal Conditioner, Filter, A/D, Front Panel.		
60.	Apply power. Is the reading zero?	61	62
61.	Replace modules one at a time until reading is not zero. Last one in is the problem. Go to Section 6.		
62.	Is the Isolator installed?	63	65
63.	Replace Isolator with Interconnect-Monitor PCB. Is the reading zero?	64	65
64.	Bad Isolator. Go to Section 6.		
65.	Install Interconnect Monitor if not already installed. Check supply voltages as follows. Test DMM LO on AR (analog return). VA1 = +14.25 to +15.75V VA4 = -29 to -32V VA2 = -14.25 to -15.75V VCC = -15V Difference must equal VA3 = +29 to +32V VSS = -20V 4.9 to 5.2V		
66.	Supply voltages in tolerance?	70	67
67.	Remove all modules except Front Panel. Supplies in tolerance?	69	68
68.	Repair power supply. Go to Figure 4-5.		
69.	Replace modules one at a time, checking supplies between modules. Last one in is faulty. Go to the appropriate figure.		
70.	Remove Filter module. CAL switch on. Select DC Volts, 1000V range.		
71.	Is the reading zero?	72	77
72.	Replace Filter module; remove DC Signal Conditioner.		

Table 4-6. Faulty Module Isolation (cont)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
73.	Place a jumper (short) between RT2 and RT6.		
74.	Is the reading zero?	75	76
75.	DC Signal Conditioner bad. Go to Figure 4-8.		
76.	Filter module bad. Go to Figure 4-9.		
77.	A/D converter bad. Go to Figure 4-10.		
78.	Do the Performance Tests earlier in this section.		
79.	Is the unit within the tolerances given?		80
80.	Is the Cal Memory installed?	81	83
81.	Remove the Cal Memory. Is the unit now within tolerance?	82	83
82.	Faulty Cal Memory.		
83.	Is the Isolator installed?	84	87
84.	Replace Isolator with Interconnect-Monitor PCB.		
85.	Is unit within tolerance?	86	87
86.	Bad Isolator. Go to Section 6.		
87.	Is the failure in DC Volts Performance Test?	89	88
88.	Go to Section 6 for the appropriate faulty function.		
89.	Remove all optional modules, leaving Front Panel, Controller, DC Signal conditioner, Active Filter, and A/D Converter.		
90.	Do the DC Volts Performance Test. Is the unit within tolerance?	91	92
91.	Reinstall options one at a time, rechecking DC Volts tolerance. Last module installed when unit becomes out of tolerance is faulty. Go to Section 6.		
92.	Check supply voltages according to the following chart. VA1 = +14.25 to +15.75V VA4 = -29 to -32V VA2 = -14.25 to -15.75V VCC = -15V Difference = 4.9 to 5.2V VA3 = +29 to +32V VSS = -20V		
93.	Are the supplies within tolerance?	97	94
94.	Remove all modules except Controller and Front Panel. Are the voltages correct?	95	96
95.	Replace modules one at a time until the voltages go bad. Last one in is the problem. Go to the appropriate figure.		
96.	Repair power supply. Go to Figure 4-5.		

Table 4-6. Faulty Module Isolation (cont)

<table>
<tr><th rowspan="2">STEP NO.</th><th rowspan="2">ACTION</th><th colspan="2">Go to the step number given for correct response</th></tr>
<tr><th>YES</th><th>NO</th></tr>
<tr><td>97.</td><td>Connect the test DMM LO to RT2 and HI to RT6. Apply known voltages to the input to test the DC Signal Conditioner. The following voltages are suggested inputs:
<table>
<tr><th>RANGE</th><th>GAIN DC SIG COND</th><th>INPUT</th><th>TEST DMM READING</th></tr>
<tr><td>100 mV</td><td>X100</td><td>2 mV</td><td>200 mV</td></tr>
<tr><td>100 mV</td><td>X100</td><td>200 mV</td><td>20.0V</td></tr>
<tr><td>1V</td><td>X10</td><td>125 mV</td><td>1.25V</td></tr>
<tr><td>1V</td><td>X10</td><td>2V</td><td>20V</td></tr>
<tr><td>10V</td><td>X1</td><td>1V</td><td>1.0V</td></tr>
<tr><td>10V</td><td>X1</td><td>19V</td><td>19.0V</td></tr>
<tr><td>100V</td><td>÷64X10</td><td>1.28V</td><td>200 mV</td></tr>
<tr><td>100V</td><td>÷64X10</td><td>128V</td><td>20.0V</td></tr>
<tr><td>1000V</td><td>÷64X1</td><td>64V</td><td>1.0V</td></tr>
<tr><td>1000V</td><td>÷64X1</td><td>960V</td><td>15.0V</td></tr>
</table>
</td><td></td><td></td></tr>
<tr><td>98.</td><td>Are the readings correct (noise or drift in the DC Signal Conditioner will show up on the Test DMM readings)?</td><td>100</td><td>99</td></tr>
<tr><td>99.</td><td>DC Signal Conditioner faulty. Go to Figure 4-8.</td><td></td><td></td></tr>
<tr><td>100.</td><td>Connect Test DMM HI to RT5. Repeat table in step 97. The test DMM readings should be the same.</td><td></td><td></td></tr>
<tr><td>101.</td><td>Are the Test DMM readings the same?</td><td>103</td><td>102</td></tr>
<tr><td>102.</td><td>Faulty Active Filter module. Go to Figure 4-9.</td><td></td><td></td></tr>
<tr><td>103.</td><td>Faulty A/D Converter. Go to Figure 4-10.</td><td></td><td></td></tr>
</table>

Table 4-7. Controller Troubleshooting

Note

Due to the speed and complexity of the Controller, it is recommended that, when a problem is isolated to the Controller, the unit be sent to the nearest Service Center for repair. The following information will assist in verifying Controller operation. Many problems require the use of an in-circuit tester.

Troubleshoot the Controller with only the Controller, Front Panel and Power Supply installed. The most common symptom of Controller failure is a blank display. Other symptoms include an improper display, a failure to read switches or respond to external interrupts, or an initialization display ("CXXXXXX") improperly indicating all optional modules present. The following checks verify basic Controller operation:

1. Check power supply voltages at the Controller. Test Points are located on the circuit board top edge and are identified on the inside of the hinged module top.

   Test DMM LO: TP1 (VSS)

   Test DMM HI: TP3 (VCC +5V)
   TP5 (VBB -5V)
   TP6 (VDD +12V)

   If any of these voltages are more than 5% out of tolerance, proceed to "Power Supply Troubleshooting" in this section.

2. If the power supply checks good, verify the presence of the following signals in sequence. If a signal is present, go on to the next check. If a signal is not present, the Controller may be faulty. Although probable fault causing components or circuits may be mentioned, the Controller will probably require repair at a Service Center.

   SYNC pulse at TP7

   If no SYNC pulse, check Ø1 at U15-22; Ø2 at U15-15. (test failure suggests U19).

   RESET signal at U10-2 on power-up: check for 0.1 sec low-going pulse. (Test failure suggests reset circuit.)

   CPUINT at TP4

   DLDACK at TP2

Table 4-8. Front Panel Troubleshooting

SYMPTOM	POSSIBLE FAILURE
No ACK Pulse	U28, U19 (Address Decoders) U23 (Indirect F/F) U19, U11, Q10 (ACK Circuit)
No Display (ACK Pulse Present)	U18 (Kill Circuit)
No Response to Switch Pushes (Display Good)	Switch Associated with Function U32, CR2-CR6 Open
Segment Bad in all LED's	Check path from Latch to Transistor drivers to LED Cathodes
One LED doesn't light	Check path from Latch to Inverter to Transistor Drivers to LED Anode
Segment or Decimal missing on only one LED	Bad LED
Display gives wrong numbers, one LED brighter	U11 (Reset to Indirect Address F/F, U23) Address Decoder. (Problem is indicative of front panel responding to an invalid address)

Table 4-9. DC Signal Conditioner Troubleshooting

SYMPTOM	POSSIBLE FAILURE
DC Inoperative all Ranges	Digital Control Logic Q8, Q6, Q7, Open K1, Q1, Q2 Open; Q18, Q19, U3 Bad
Display Blanks	U1 or U2
Locks in Overrange	U3
Reading Drifts	U4; Q14, Q15, Q16 Leaky
Won't Zero	U5 or U6
100 mV Range Bad	Q31, Q32, Q14
1V and 100V Range Bad	Q33, Q34, Q15
100V and 1000V Range Bad	K2, Q3, Q4
Random Readings	K1 Open, K2 Shorted
Nonlinear Readings	Q16, Q15, Q14 Leaky

ADDRESS AND DATA FIELD

DC SIGNAL CONDITIONER ADDRESS: IC, IC3, IC0 = 1

GAIN CONTROL

ID3	ID2	GAIN
0	1	X100
1	0	X10
1	1	X1

INPUT CONFIGURATION CONTROL

ID1	ID0	INPUT FROM	ATTENUATION
1	0	External	÷1
0	0	External	÷64
0	1	RT1*	÷1

*Used for ohms and dc current measurements.

NOTE: If R54-R57, Q18, Q19 or Q22 are replaced it will be necessary to return the module to the factory (attn. PARTS) to be temperature compensated anew.

Table 4-10. Active Filter Troubleshooting

SYMPTOM	POSSIBLE FAILURE
High Zero Offset	Q32, Q25, Q19, Q20 Shorted
DC Inoperative	Q18 Open - Q21, Q22, Q23, Q24 Open Q27, U5 Digital Logic
Overrange	U5 - Q19, Q20 Shorted
Noisy	
All Ranges	
Either Filter	Q25, Q32 Leaky - Q31, U5 Bad
Slow Filter (ON)	Q21, Q22 Leaky - U4 Bad
Fast Filter (OFF)	Q23, Q24 Leaky - U3 Bad
Nonlinear Readings	U5
Display Blanks	U1 or U2

ADDRESS AND DATA FIELD

ADDRESS	DATA
IC4, IC3, & IC1 = 1	ID0 = Filter Bypass ID1 = 1 Slow Filter ID2 = 1 Fast Filter ID3 = 1 Filter - Always on except in Ext. Ref. ID4 = 1 Ext. Ref. Lo ID5 = 1 Ext. Ref. Hi

Adjustment of R14

1. Short the UUT input terminals, and select 10V dc range.
2. Short RT6 to RT2 on the Bus Interconnect Monitor.
3. Adjust R14 for a reading of ±.000000 ±2 digits. (This requires that the A/D Converter is working accurately.)

Selection of R15 or R16.

If Q27 or U5 have been replaced, R15 and R16 will require reselection if adjustment of R14 does not zero the reading.

1. Only one of R15 and R16 will be installed. Replace whichever is installed with a short.
2. Connect the R15 short to the R16 short.
3. Short RT6 to RT2 on the Bus Interconnect Monitor.
4. Connect the test DMM HI to TP3 and LO to TP1 on the Active Filter module.
5. Select a resistor from the table below according to the measured offset. If the polarity is postive, install the resistor as R16; if negative as R15. (Maximum allowable offset in this step is 5200 μV.)

OFFSET (μV)	RESISTOR	FLUKE PART NO.
0-400	None	
401-1200	31.6k	261610
1201-2000	63.4K	235382
2001-2800	97.6K	241380
2801-3600	133.0K	289074
3601-4400	165.0K	376186
4401-5200	205.0K	375931

6. After installing the resistor, adjust R14.

Table 4-11. R^2 A/D Converter Troubleshooting

DIGITAL BOARD

SYMPTOM	POSSIBLE FAILURE
Display Blanks	U33, U34, U35 (Affecting ID Lines)
Improper Readings, Inoperative A/D, Nonlinear Readings	Check Transistor Array Outputs to J1 and J2 — The rise and fall times of these Switching Pulses Must be <2 μsec.
Flickering Display	Autozero Control — U25, U34
Direct Address	
IC4, 3, & 2 High	ID0 = 1 = Reset Counter ID1 = 1 = Auto Zero ID2 = 0 = Buffer Input ID2 = 1 = Remainder Input ID3 = 1 = Channel X (Auto Zero and remainders 1 and 3) ID3 = 0 = Channel Y (Remainders 2 and 4)
Indirect Address	
IC2 & 1 High (and Ring Counter not in C0 time period, C0 = 0)	This Indirect Address allows the ID7 enable to bring back Polarity Bits to the Controller Module

ANALOG BOARD

First Check TP5 — Should be switching between + and -7V. Typical failures in this circuit result in a portion of the switching slope having a slew rate less than 1V/μsec. A glitch at the zero point is normal.

SYMPTOM	POSSIBLE FAILURE
Noisy Readings	U1, U2, U3
Nonlinear Ladder	U4, Q9, Q10 (Q27)
Ladder out of Tolerance	FETS Q11-Q15 or Q17-Q21
All Digits Wrong	U7, Q31, Q32
Reading Locked (Doesn't Respond to Input Change) or Always Overrange	U4, Q9, U1, U2, U3, Q2, Q3
Bad Remainders (Lesser Digits)	Q22, U4, U6
No Polarity Bit Returned	Q29, Q28
Shifty Readings (Most or all Digits)	Autozero Settling Time Problems U8, Q30-Q8, Q7

NOTE: If U1, R9, R14-R16, R34, R35, R50-55, R67, Q1-Q3, Q11-Q16, Q25, or Q26 are replaced it will be necessary to return the module to the factory (attn. PARTS) to be temperature compensated anew.

4-83. Troubleshooting Notes

4-84. Latching errors are normally enabled, but are afforded special treatment for troubleshooting purposes when the Calibration mode is on. The following rules then apply:

1. Latching errors are automatically enabled whenever Calibration mode is enabled or disabled with the rear panel Calibration Switch.

2. If Calibration mode is on, latching errors can be disabled by pushing the AVG button. Since Average mode and Calibration mode are mutually exclusive, this operation does not enable Average mode. The multimeter front panel display responds with (Err. oFF).

3. With Calibration mode still on, latching errors are re-enabled and normal Calibration mode operation is restored when the AVG button is pushed again. If a latching error condition exists at this time, the error message is displayed. If no latching error exists, the multimeter front panel display responds with (Err. on).

CAUTION

Since latching errors may also identify an over voltage condition (as with Error 4) discretion must be used. Do not disable latching errors during normal multimeter operation or during calibration

4-85. If interaction between modules is a problem during troubleshooting, use of either the Static Controller or the Test Module could be helpful. With the Static Controller, bus IC, ID, and handshake signals may be applied separately to most analog and digital modules. The Test Module may be used to either check or troubleshoot the Controller module. Complete use information and troubleshooting techniques are provided with these test modules.

NOTE

Ground integrity within the multimeter is maintained via one of the Power Supply securing screws. If this screw is loose or missing, noise problems can be encountered. Viewing the multimeter from the rear, locate the three buttonhead screws along the left side of the heat sink. Verify that the middle screw is tightly secured.

4-86. Use the Bus Interconnect and Monitor Board (MIS-7013K) to access lines on either the digital (unguarded) or analog (guarded) interbus. In using the Bus Interconnect Monitor Board, note that RT1 physically does not extend to the Isolator-Interconnect slot. RT1 is accessible with the Monitor Board installed in any of the first four slots (J11A, B, C, or D). The output of the optional Ohms Converter and Current Shunts modules are on RT1.

CAUTION

Do not apply an input directly to the A/D Converter module. Damage to the A/D Converter may result. The DC Signal Conditioner may be bypassed by applying a signal directly to the Active Filter module, as outlined in the module isolation procedure.

4-87. Care should be exercised when soldering on multilayer printed circuit boards. Excessive heat can be especially ruinous. Note the following considerations:

1. Excessive heat can cause unseen damage to board laminations and through-hole plating.

2. Soldering tip temperatures above 700° F should be avoided in all cases.

3. Whenever possible, alternate soldering tool usage between divergent areas on a board. Concentration of heat in any one area will, thereby, be minimized.

4-88. Non-recurring Adjustments

4-89. Variable resistor R9 in the U3 Regulator circuit of the Power Supply Assembly is set at the factory and should not require additional adjustment. If any other Power Supply components are replaced, use the following procedure:

1. Connect a test DMM between –15V (VA2) and ANALOG RETURN (AR) at TP4 and TP6 respectively.

2. Record the value of the reading.

3. Connect the test DMM between +15V (VA1) and AR at TP3 and TP6 respectively.

4. Adjust R9 until the test DMM reads within ± 0.25V of the reading recorded in step 2 above.

5. Recheck the –15V and +15V supplies at the points given in steps 1 and 3 above respectively and verify that they read –15 ± 0.75V and +15 ± 0.75V. If either is outside the stated tolerance repeat steps 1 through 4 until both values are within tolerance.

Section 5
List of Replaceable Parts

TABLE OF CONTENTS

ASSEMBLY NAME	DRAWING NO.	TABLE		FIGURE	
		NO.	PAGE	NO.	PAGE
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A1 Front Panel Display Assembly	8505A-4001T	5-2	5-7	5-2	5-9
A2 Motherboard PCB Assembly	8505A-4002T	5-3	5-10	5-3	5-11
A3 Bus Interconnect PCB Assembly	MIS-4081	5-4	5-12	5-4	5-12
A4 Power Supply PCB Assembly	8505-4051T	5-5	5-13	5-5	5-15
A5 Power Supply Interconnect	8505A-4004	5-6	5-17	5-6	5-17
A6 Controller PCB Assembly	8505A-4187T	5-7	5-18	5-7	5-20
A7 Front/Rear Switch PCB Assembly	8505A-4005T	5-8	5-21	5-8	5-22
A8 DC Signal Conditioner PCB Assembly	MIS-4100T	5-9	5-23	5-9	5-26
A9 Active Filter PCB Assembly	MIS-4130T	5-10	5-27	5-10	5-29
A10 Fast R^2 A/D Converter Assembly	MIS-4140T	5-11	5-30	5-11	5-30
-08A Isolator PCB Assembly (Part of the Standard Unit)	——— (See Section 6)	608A-3	608A-5	608A-3	608A-7

NOTE: Optional equipment, see Section 6.

5-1. INTRODUCTION

5-2. This section contains an illustrated parts breakdown of the instrument. A similiar parts list is included in the Options and Accessories Section for each of the options. Components are listed alphanumerically by assembly. Both electrical and mechanical components are listed by reference designation. Each listed part is shown in an accompanying illustration.

5-3. Parts lists include the following information:

1. Reference Designation.
2. Description of Each Part.
3. FLUKE Stock Number.
4. Federal Supply Code for Manufacturers.
5. Manufacturer's Part Number.
6. Total Quantity of Components Per Assembly.
7. Recommended quantity: This entry indicates the recommended number of spare parts necessary to support one to five instruments for a period of 2 years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for 1 year or more at an isolated site, it is recommended that at least one of each assembly in the instrument be stocked. In the case of optional subassemblies, plug-ins, etc., that are not always part of the instrument or are deviations from the basic instrument model, the REC QTY column lists the recommended spares quantity for the items in that particular assembly.

5-4. HOW TO OBTAIN PARTS

5-5. Components may be ordered directly from the manufacturer's part number, or from the John Fluke Mfg. Co., Inc. or an authorized representative by using the FLUKE STOCK NUMBER. In the event the part ordered has been replaces by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions if necessary.

5-6. To ensure prompt and efficient handling of your order, include the following information.

1. Quantity.
2. FLUKE Stock Number.
3. Description.
4. Reference Designation.
5. Printed Circuit Board Part Number and Revision Letter.
6. Instrument Model and Serial Number.

5-7. A Recommended Spare Parts Kit for your basic instrument is available from the factory. This kit contains those items listed in the REC QTY column for the parts lists in the quantities recommended.

5-8. Parts price information is available from the John Fluke Mfg. Co., Inc. or its representative. Prices are also available in a Fluke Replacement Parts Catalog, which is available upon request.

CAUTION

Indicated devices are subject to damage by static discharge.

Table 5-1. 8505A Final Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
	⊗ FINAL ASSEMBLY FIGURE 5-1 (8505A-5001, T&B)	8505A	89536	8505A			
A1	⊗ FRONT PANEL DISPLAY ASSEMBLY	639419	89536	639419	1		
A2	MOTHER BOARD	639385	89536	639385	1		
A3	BUS INTERCONNECT ASSEMBLY	459636	89536	459636	1		
A4	POWER SUPPLY ASSEMBLY	683946	89536	639526	1		
A5	POWER SUPPLY INTERCONNECT	660563	89536	646273	1		
A6	⊗ CONTROLLER ASSEMBLY	638544	89536	638544	1		
A7	FRONT REAR SWITCH ASSEMBLY	646281	89536	646281	1		
A8	⊗ DC SIGNAL CONDITIONER	660712	89535	646307	1		
A9	⊗ ACTIVE FILTER ASSEMBLY	383976	89536	383976	1		
A10	⊗ FAST R2 A/D CONVERTER ASSEMBLY	383984	89536	383984	1		
-08A	ISOLATOR PCB ASSEMBLY (SEE SECTION 6, -08A)	PART OF STANDARD UNIT			1		
H1	NUT, HEX, 1/4-28	110619	89536	110619	1		
H2	SCREW, CAP, 8-32 X 3/8	295105	89536	295105	4		
H3	SCREW, FHP, 8-32 X 3/8	114116	89536	114116	8		
H4	SCREW, SBH, HEX, 8-32 X 1/2	658591	89536	658591	4		
H5	SCREW, FHP, UNDERCUT, 6-32 X 1/4	320093	89536	320093	12		
H6	SCREW, PHP, W/LOCKWASHER, 6-32 X 1/4	178533	89536	178533	15		
H7	SCREW, SBH, HEX, 6-32 X 1/4	528281	89536	528281	4		
H8	SCREW, PHP, 6-32 X 1/2	114397	89536	114397	4		
H9	SCREW, PHP, 6-32 X 1/4	152140	89536	152140	8		
H10	SCREW, PHP, 6-32 X 5/16	152157	89536	152157	8		
H11	SCREW, FHP, 8-32 X 7/16	306159	89536	306159	6		
H12	SCREW, SBH, HEX, 8-32 X 3/8	658583	89536	658583	2		
H13	WASHER, LOCK, INTERNAL TOOTH, 1/4	110817	89536	110817	1		
H14	WASHER, LOCK, INTERNAL TOOTH, #6	110338	89536	110338	12		
H15	SCREW, PHP, 6-32 X 7/16	362954	89536	362954	6		
H16	NUT, HEX, 6-32	110569	89536	110569	4		
H17	SCREW, PHP, 4-40 X 1/8	198200	89536	198200	4		
H18	WASHER, SPRING STEEL,	543405	89536	543405	14		
MP1	BAIL, INSTRUMENT	523571	89536	523571	2		
MP2	BEZEL, I/O	416206	89536	416206	1		
MP3	BULKHEAD	645887	89536	645887	1		
MP4	BULKHEAD, CENTRAL	656652	89536	656652	1		
MP5	CORD SET, W/FEMALE PLUG (not shown)	284174	89536	284174	1		
MP6	COVER, BOTTOM	646182	89536	646182	1		
MP7	DECAL, LENS	659565	89536	659565	1		
MP8	COVER, TOP	646174	89536	646174	1		
MP9	CORNER HANDLE, FRONT	656165	89536	656165	2		
MP10	CORNER, PLASTIC	656215	89536	656215	2		
MP11	DECAL, FRONT PANEL	640367	89536	640367	1		

Table 5-1. 8505A Final Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
MP12	FOOT, MOLDED	645945	89536	645945	4		
MP13	FOOT, SINGLE BAIL, (DARK UMBER)	653923	89536	653923	4		
MP14	FRONT PANEL	639492	89536	639492	1		
MP15	FRONT PANEL, MOLDED	646240	89536	646240	1		
MP16	LATCH MODULE GUIDE	646232	89536	646232	20		
MP17	CHASSIS, LEFT SIDE	656371	89536	656371	1		
MP18	PLUG, HOLE	187799	89536	187799	2		
MP19	GUIDE, MOLDED MODULE	646224	89536	646224	20		
MP20	ROD, MOLDED PUSH	646216	89536	646216	3		
MP21	PUSHBUTTON, "EXT/GD IN"	660381	89536	660381	1		
MP22	POST, BINDING, GROUNDING TYPE	225615	20584	3575	1		
MP23	POST, BINDING, GROUNDING TYPE	225623	20584	3576	1		
MP24	PUSHBUTTON, "F/R"	660399	89536	660399	1		
MP25	PUSHBUTTON, "4T/2T"	660373	89536	660373	1		
MP26	REAR PANEL, SCREEN	660308	89536	660308	1		
MP27	CHASSIS, RIGHT SIDE	638569	89536	638569	1		
MP28	SHIELD, MOTHER BOARD	660282	89536	660282	1		
MP29	DECAL, POWER SUPPLY	659649	89536	659649	1		
MP30	SHIELD, BOTTOM COVER	660258	89536	660258	1		
MP31	DECAL, REAR CORNER	685222	89536	685222	2		
MP32	DECAL, SIDE TRIM	525980	89536	525980	2		
MP33	DECAL, FRONT CORNER	659219	89536	659219	2		
MP34	CONNECTOR, CABLE PLUG	369231	91662	00-8016-000-703	1		
MP35	SCAN ADVANCE ASSY, BNC	651810	89536	651810	1		
MP36	TRIGGER (EXT) ASSY, BNC	651802	89536	651802			
MP37	PLUG, FEMALE, 3 WIRE (not shown)	284174	89536	284174	1		
MP38	CONTACT, CRIMP (not shown)	369280	89536	369280	9		
MP39	CONTACT, SOLDER (not shown)	369298	89536	369298	9		
TM1	MANUAL, INSTRUCTION	638841	89536	638841			
	RECOMMENDED SPARE PARTS KIT, 8505A	661165	89536	661165			

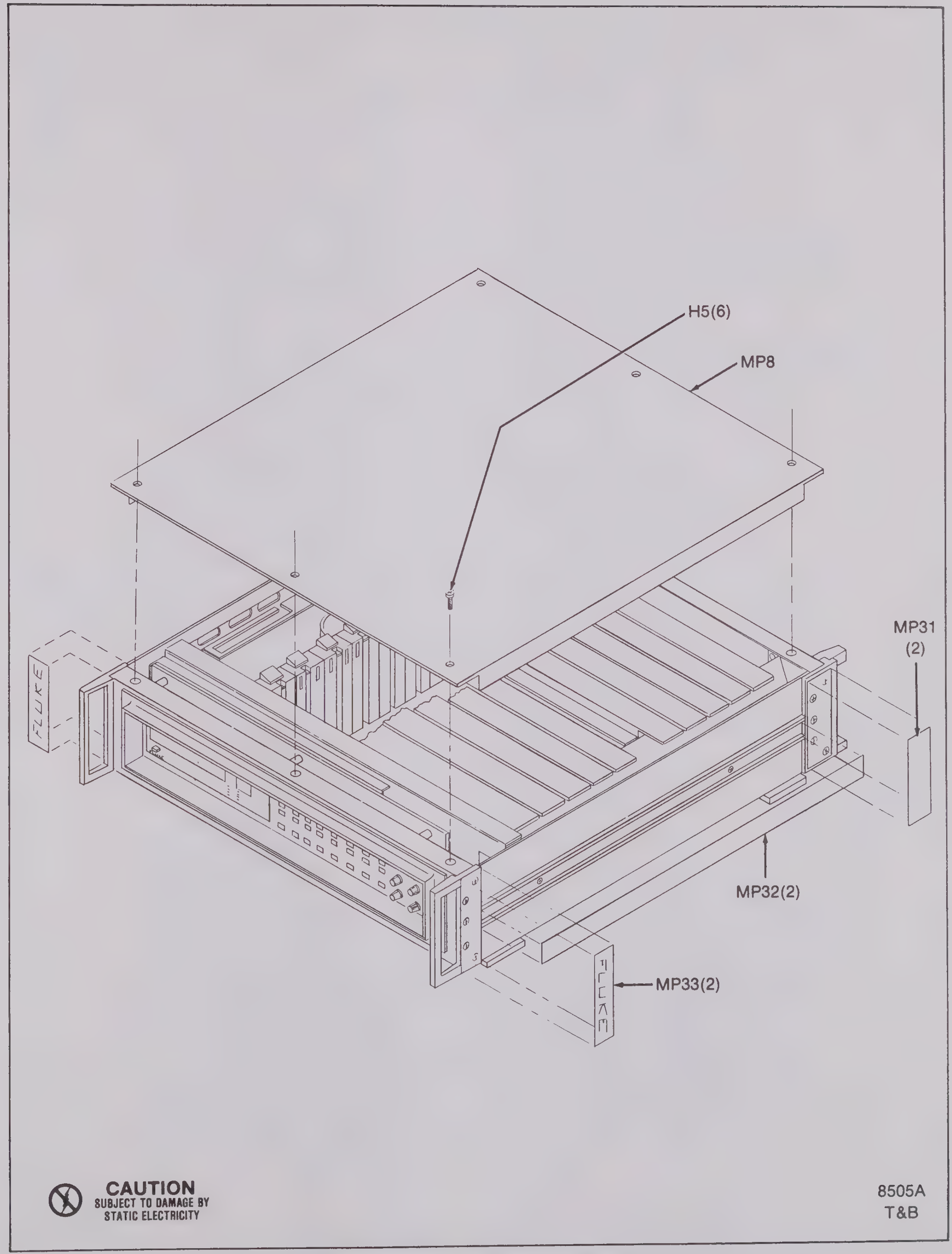

H5(6)
MP8
MP31
(2)
MP32(2)
MP33(2)
FLUKE
FLUKE
CAUTION
SUBJECT TO DAMAGE BY
STATIC ELECTRICITY
8505A
T&B

Figure 5-1. 8505A Final Assembly

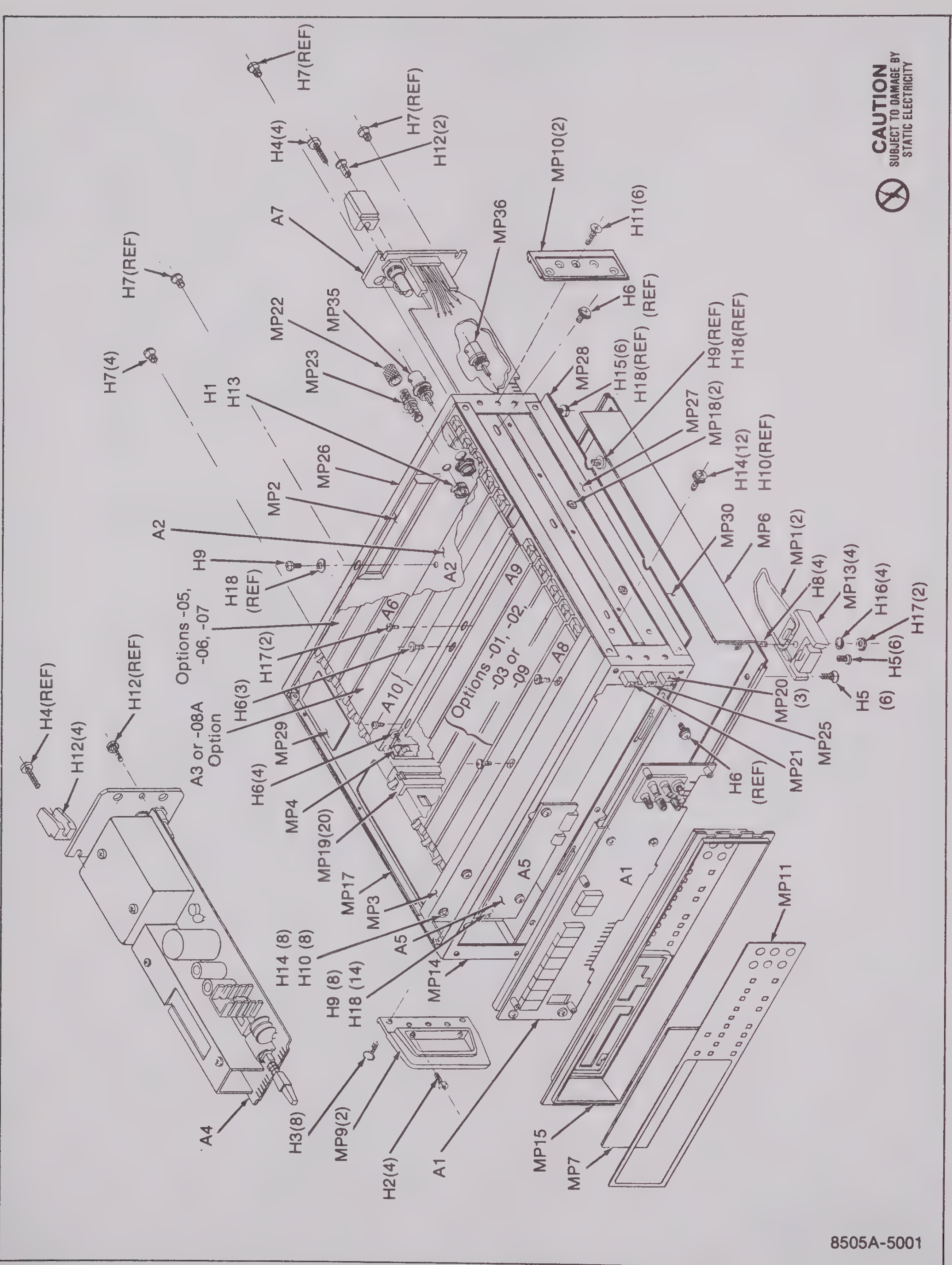

CAUTION
SUBJECT TO DAMAGE BY STATIC ELECTRICITY
H7(REF)
H7(REF)
H4(4)
H12(2)
A7
MP10(2)
H11(6)
MP36
H7(REF)
MP22
MP35
MP23
H6
(REF)
MP28
H15(6)
H18(REF)
H9(REF)
H18(REF)
H7(4)
H1
H13
MP27
MP18(2)
MP26
H14(12)
H10(REF)
MP2
A2
A2
MP30
MP6
MP1(2)
H9
H18
(REF)
H8(4)
MP13(4)
H16(4)
H17(2)
Options -05,
-06, -07
A9
A6
H5(6)
H17(2)
H5
(6)
H6(3)
Options -01, -02,
-03 or
-09
A8
MP20
(3)
A3 or -08A
Option
A10
MP25
MP29
H4(REF)
H12(REF)
H12(4)
H6(4)
H6
(REF)
MP21
MP4
MP19(20)
MP17
MP3
A5
A1
MP11
H14 (8)
H10 (8)
A5
H9 (8)
H18 (14)
MP14
A4
H3(8)
MP9(2)
H2(4)
A1
MP15
MP7
8505A-5001

Figure 5-1. 8505A Final Assembly (cont)

Table 5-2. A1 Front Panel Display Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
A1	FRONT PANEL DISPLAY ASSEMBLY FIGURE 5-2 (8505A-4001T)	639419	89536	639419	REF		
C1	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW3C0C224K	1		
C2	CAP, ELECT, 47 UF +75/-20%, 25V	655191	89536	655191	2		
C3	CAP, CER, 1200 PF +/-20%, 100V	358283	80031	2222-630-01-122	1		
C4	CAP, ELECT, 47 UF +75/-20%, 25V	655191	89536	655191	REF		
CR1-CR6	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	6		2
CR7	LIGHT EMITTING DIODE (LED)	504761	14936	MV57124	1		1
F1	FUSE, FAST ACTING, 1-1/2 AMP	109330	71400	AGC1-1/2	1		5
F2	WIRE, 0.0063 DIA, #36	160978	89536	160978	A/R		
H1	SCREW, PHP, 6-32 X 1/4 (not shown)	152140	89536	152140	6		
H2	WASHER, BELLEVILLE, #6 (not shown)	571968	89536	571968	6		
J1	BINDING POST, RED	275552	32767	820-65	2		
J2	BINDING POST, RED	275552	32767	820-65	REF		
J3	BINDING POST, BLACK	275560	32767	820-45	2		
J4	BINDING POST, BLACK	275560	32767	820-45	REF		
J5	BINDING POST, BLUE	275578	32767	820-55	1		
MP1	FUSEHOLDER	435628	89536	435628	1		
MP2	CAP, FUSE	455857	89536	455857	1		
MP3	PUSHBUTTON, DARK PUTTY GREY (w/S16, S17, S18)	406728	89536	406728	3		
MP4	PUSHBUTTON, BLUE (w/S19)	406736	89536	406736	1		
MP5	PUSHBUTTON, WHITE (w/S1-S5, S10-S14, S20-S23)	406744	89536	406744	14		
MP6	PUSHBUTTON, GREY (w/S7, S24, S27)	401307	89536	401307	5		
MP7	PUSHBUTTON (w/S8, S9)	419937	89536	419937	2		
MP8	SPACER, 0.062 DIA	484832	89536	484832	1		
MP9	SHIELD, DISPLAY (not shown)	646166	89536	646166	1		
MP10	SPACER, SWITCH, 6-32 X 1/2 (not shown)	284380	89536	284380	5		
Q1	TRANSISTOR, SI, NPN	330803	04713	MPS6560	1		1
Q2-Q8	TRANSISTOR, SI, PNP	340026	04713	MPS6563	7		2
Q10	TRANSISTOR, SI, PNP	226290	04713	MPS3640	1		1
R1	RES, DEP. CAR, 62 +/-5%, 1/4W	441634	80031	CR251-4-5P62E	1		
R2	RES, DEP. CAR, 200 +/-5%, 1/4W	441451	80031	CR251-4-5P200E	2		
R3	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	1		
R4	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	1		
R5	RES, COMP, 4.7K +/-5%, 1/4W	348821	01121	CB4725	1		
R6	RES, DEP. CAR, 200 +/-5%, 1/4W	441451	80031	CR251-4-5P200E	REF		
R8	RES, COMP, 10M +/-5%, 1/4W	194944	01121	CB1065	1		
S1-S27	SWITCH, MOMENTARY (S6, S15 not used)	507319	89536	507319	25		

Figure 5-2. A1 Front Panel Display Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
TP1,TP2	TERMINAL, TEST POINT (not shown)	179283	89536	179283	2		
U1	IC, NPN XSTR ARRAY	407866	49671	CA3081	3	1	
U2	⊗ IC, CMOS, HEX INVERTER	404681	02735	CD4069BE	1	1	
U3	⊗ IC, CMOS, HEX D FLIP-FLOP	404509	12040	MM74C174N	3	1	
U4	LED, DISPLAY	504787	28480	5082-7656	2	1	
U5-U10	LED, DISPLAY, 7-SEGMENT	418012	28480	5082-7651	8	2	
U11	⊗ IC, CMOS, QUAD 2-INPUT NAND GATE	355198	04713	MC14011UBCP	1	1	
U12	LED, DISPLAY	504787	28480	5082-7656	REF		
U13	LED, DISPLAY, 7-SEGMENT	418012	28480	5082-7651	REF		
U16	⊗ IC, CMOS, DUAL D FLIP-FLOP	340117	02735	CD4013AE	3	1	
U17	RES, DIL, 60 +/-5%, 1 1/2W	344069	89536	344069	2	1	
U18	⊗ IC, CMOS, DUAL RETRIG/RESET MONOSTABLE	393512	02735	CD4098AE	1	1	
U19	⊗ IC, CMOS, DUAL 4-INPUT NAND GATE	355206	04713	MM14012CP	1	1	
U20	RES, DIL, 60 +/-5%, 1 1/2W	344069	89536	344069	REF		
U21	IC, NPN XSTR ARRAY	407866	49671	CA3081	REF		
U22	⊗ IC, CMOS, DUAL D FLIP-FLOP	340117	02735	CD4013AE	REF		
U23	⊗ IC, CMOS, DUAL D FLIP-FLOP	340117	02735	CD4013AE	REF		
U25	IC, NPN XSTR ARRAY	407866	49671	CA3081	REF		
U26	DISPLAY BAR GRAPH, RED	650796	28480	HDSP4830	REF		
U27	⊗ IC, CMOS, HEX D FLIP-FLOP	404509	12040	MM74C174N	REF		
U28	⊗ IC, CMOS, TRIPLE 3-INPUT NAND GATE	375147	02735	CD4023AE	1	1	
U29	RES, DIL, 1K +/-5%, 1 3/4W	358119	89536	358119	2	1	
U30	RES, DIL, 1K +/-5%, 1 3/4W	358119	89536	358119	REF		
U31	⊗ IC, CMOS, HEX D FLIP-FLOP	404509	12040	MM74C174N	REF		
U32	⊗ IC, CMOS, HEX BUFFER-TRI STATE	407759	12040	MM80C97N	1	1	
U33	RES, DIL, 4.7K +/-5%, 1 1/2W	386961	89536	386961	1	1	
U34	LED, DISPLAY, 7-SEGMENT	418012	28480	5082-7651	REF		

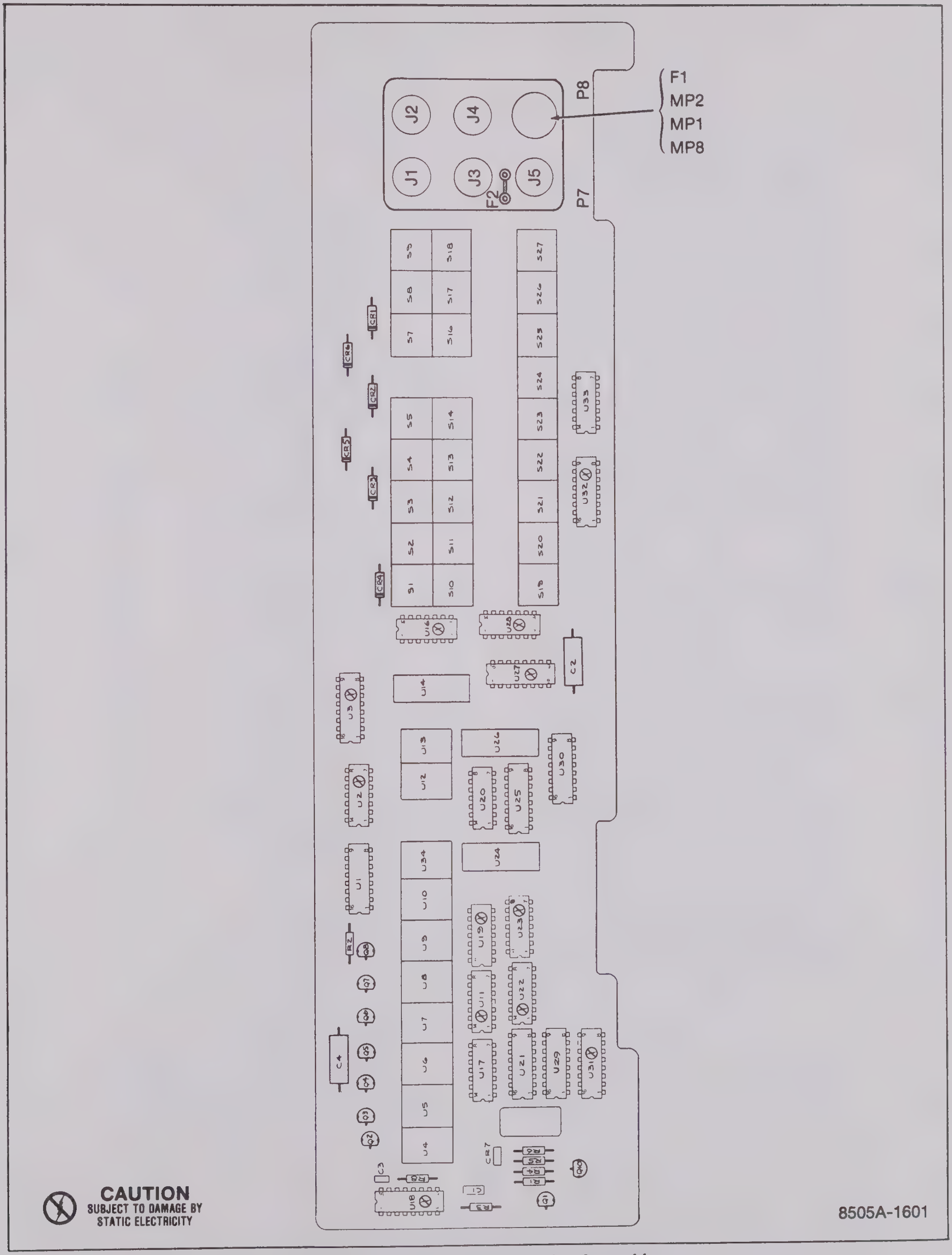

F1
MP2
MP1
MP8
P8
P7
J2
J4
J1
J3
J5
F2
S9
S8
S7
S18
S17
S16
S5
S4
S3
S2
S1
S14
S13
S12
S11
S10
S27
S26
S25
S24
S23
S22
S21
S20
S19
CR1
CR6
CR2
CR5
CR3
CR4
U33
U32
U16
U28
C2
U27
U14
U3
U13
U12
U26
U30
U20
U25
U2
U1
U34
U10
U9
U8
U7
U6
U5
U4
U24
U19
U23
U11
U22
U17
U21
U29
U31
R2
Q8
Q7
Q6
Q5
Q4
Q3
Q2
C4
CR7
R6
R5
R4
R1
C3
R8
U18
C1
R3
Q1
CAUTION
SUBJECT TO DAMAGE BY
STATIC ELECTRICITY
8505A-1601

Figure 5-2. A1 Front Panel Display Assembly

Table 5-3. A2 Mother Board PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
A2	MOTHER BOARD PCB ASSEMBLY FIGURE 5-3 (8505A-4002T)	639385	89536	639385	REF		
J1	CONNECTOR, BD EDGE, RECPT, 8-PIN	354951	00779	583407-5	3		
J2	CONNECTOR, BD EDGE, RECPT, 18-PIN	291906	00779	583650-3	1		
J3	CONNECTOR, BD EDGE, RECPT, 4-PIN	417550	00779	1-583694-1	7		
J5	CONNECTOR, BD EDGE, RECPT, 4-PIN	417550	00779	1-583694-1	REF		
J6	CONNECTOR, BD EDGE, RECPT, 20-PIN	291914	00779	583650-4	1		
J8	CONNECTOR, BD EDGE, RECPT, 4-PIN	417550	00779	1-583694-1	REF		
J9	CONNECTOR, BD EDGE, RECPT, 16-PIN	408484	00779	583407-9	1		
J11A	CONNECTOR, BD EDGE, RECPT, 40-PIN	422550	00779	2-583407-0	12		
J11B	CONNECTOR, BD EDGE, RECPT, 40-PIN	422550	00779	2-583407-0	REF		
J11C	CONNECTOR, BD EDGE, RECPT, 40-PIN	422550	00779	2-583407-0	REF		
J11D	CONNECTOR, BD EDGE, RECPT, 40-PIN	422550	00779	2-583407-0	REF		
J12A	CONNECTOR, BD EDGE, RECPT, 6-PIN	291625	00779	583650-1	4		
J12B	CONNECTOR, BD EDGE, RECPT, 6-PIN	291625	00779	583650-1	REF		
J12C	CONNECTOR, BD EDGE, RECPT, 6-PIN	291625	00779	583650-1	REF		
J12D	CONNECTOR, BD EDGE, RECPT, 6-PIN	291625	00779	583650-1	REF		
J13A	CONNECTOR, BD EDGE, RECPT, 4-PIN	417550	00779	1-583694-1	REF		
J13B	CONNECTOR, BD EDGE, RECPT, 4-PIN	417550	00779	1-583694-1	REF		
J13C	CONNECTOR, BD EDGE, RECPT, 4-PIN	417550	00779	1-583694-1	REF		
J13D	CONNECTOR, BD EDGE, RECPT, 4-PIN	417550	00779	1-583694-1	REF		
J14	CONNECTOR, BD EDGE, RECPT, 8-PIN	354951	00779	583407-5	REF		
J17	CONNECTOR, BD EDGE, RECPT, 8-PIN	354951	00779	583407-5	REF		
J21G	CONNECTOR, BD EDGE, RECPT, 40-PIN	422550	00779	2-583407-0	REF		
J22H	CONNECTOR, BD EDGE, RECPT, 40-PIN	422550	00779	2-583407-0	REF		
J23H	CONNECTOR, BD EDGE, RECPT, 40-PIN	422550	00779	2-583407-0	REF		
J29K	CONNECTOR, BD EDGE, RECPT, 40-PIN	422550	00779	2-583407-0	REF		
J30K	CONNECTOR, BD EDGE, RECPT, 40-PIN	422550	00779	2-583407-0	REF		
J31L	CONNECTOR, BD EDGE, RECPT, 40-PIN	422550	00779	2-583407-0	REF		
J31M	CONNECTOR, BD EDGE, RECPT, 40-PIN	422550	00779	2-583407-0	REF		
J31N	CONNECTOR, BD EDGE, RECPT, 40-PIN	422550	00779	2-583407-0	REF		
MP1	CONNECTOR PIN	267500	00779	87022-1	4		
MP2	KEY INSERT, CONNECTOR POLARIZING	293498	89536	293498	14		
MP3	INSULATOR, MYLAR .005	380923	89536	380923	A/R		
MP4	SPACER, SWAGE, 4-40 X .020	343996	89536	343996	2		
MP5	SPACER, SWAGE, 6-32 X .187	351882	89536	351882	3		
Q1	TRANSISTOR, SI, PHOTO, LIGHT DETECTOR	271791	04713	2N5777	1	1	
R3	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	1		
S1	SWITCH, SLIDE	697466	89536	697466	1	1	

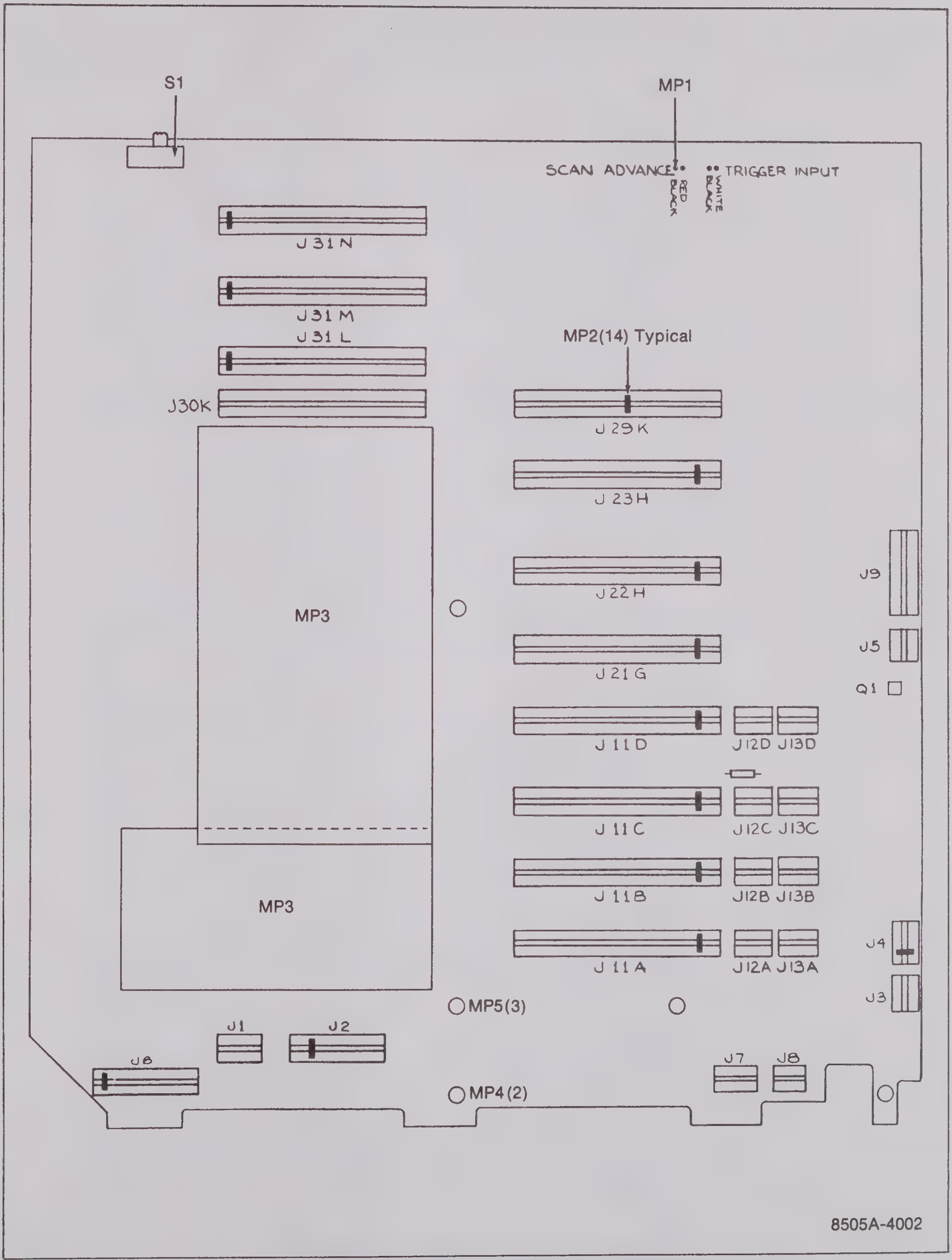
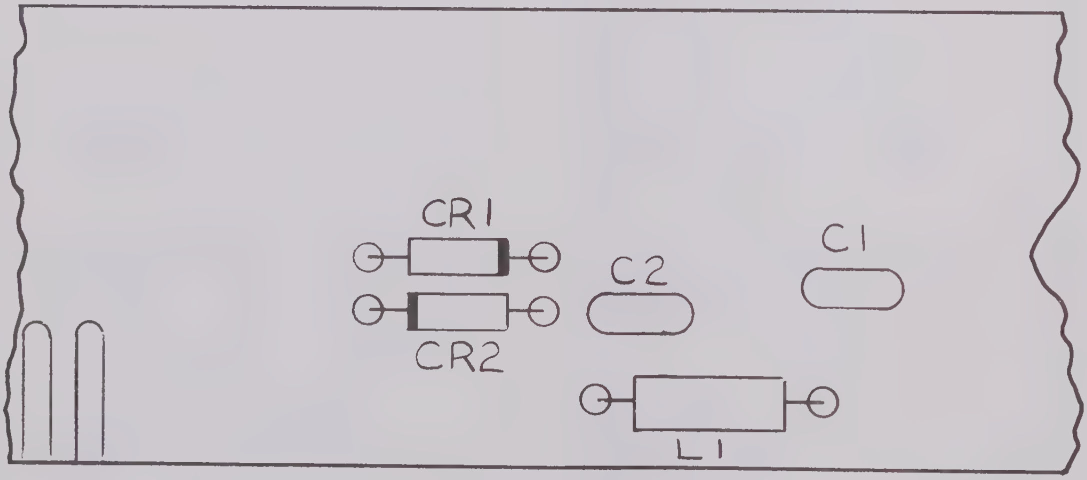

S1
MP1
SCAN ADVANCE
RED
BLACK
WHITE
BLACK
TRIGGER INPUT
J31N
J31M
J31L
J30K
MP2(14) Typical
J29K
J23H
J22H
J21G
J11D
J12D
J13D
J11C
J12C
J13C
J11B
J12B
J13B
J11A
J12A
J13A
MP3
MP3
J9
J5
Q1
J4
J3
MP5(3)
MP4(2)
J1
J2
J8
J7
J8
8505A-4002

Figure 5-3. A2 Mother Board PCB Assembly

Table 5-4. A3 Bus Interconnect PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
A3	BUS INTERCONNECT PCB ASSEMBLY FIGURE 5-4 (MIS-4081)	459636	89536	459636	REF		
C1	CAP, TA, 220 UF +/-20%, 6V	408682	56289	196D227X0006TE4	2		
C2	CAP, TA, 220 UF +/-20%, 6V	408682	56289	196D227X0006TE4	REF		
CR1	DIODE, SI, RECT, 1 AMP	343491	01295	1N4002	1	1	



MIS-1681

Figure 5-4. A3 Bus Interconnect PCB Assembly

Table 5-5. A4 Power Supply PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
A4	POWER SUPPLY PCB ASSEMBLY FIGURE 5-5 (8505A-4051T)	639526	89536	639526	REF		
BR1	RECTIFIER BRIDGE	296509	09423	FB200	3	1	
BR2	RECTIFIER BRIDGE	296509	09423	FB200	REF		
BR3	RECTIFIER BRIDGE	296509	09423	FB200	REF		
BR4	RECTIFIER BRIDGE	586115	14936	KBL005	1	1	
C1	CAP, ELECT, 330 UF +/-25%, 50V	484436	89536	484436	2		
C2	CAP, ELECT, 330 UF +/-25%, 50V	484436	89536	484436	REF		
C3	CAP, ELECT, 470 UF -10/+50%, 50V	478792	89536	478792	4		
C4	CAP, ELECT, 470 UF -10/+50%, 50V	478792	89536	478792	REF		
C5	CAP, ELECT, 3,300 UF, 16/20V	603472	89536	603472	1		
C6	CAP, ELECT, 470 UF -10/+50%, 50V	478792	89536	478792	REF		
C7	CAP, ELECT, 470 UF -10/+50%, 50V	478792	89536	478792	REF		
C8	CAP, ELECT, 15,000 UF, 16/20V	603480	89536	603480	1		
C9	CAP, TA, 5.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	4		
C10	CAP, TA, 5.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	REF		
C11	CAP, TA, 5.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	REF		
C12	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW3COC224K	4		
C13	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW3COC224K	REF		
C14	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW3COC224K	REF		
C15	CAP, DISC, 5000 PF +/-20%, 3000V	485839	89536	485839	2		
C16	CAP, DISC, 5000 PF +/-20%, 3000V	485839	89536	485839	REF		
C17	CAP, TA, 5.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	REF		
C18	CAP, TA, 1 UF +/-20%, 35V	161919	56289	196D010X0035G	3		
C19	CAP, TA, 1 UF +/-20%, 35V	161919	56289	196D010X0035G	REF		
C20	CAP, TA, 1 UF +/-20%, 35V	161919	56289	196D010X0035G	REF		
C21	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW3COC224K	REF		
CR1	DIODE, SI, RECT. 2A, 50V	347559	05277	1N5400	3	1	
CR2	DIODE, SI, RECT. 2A, 50V	347559	05277	1N5400	REF		
CR3	DIODE, SI, RECT, 1A	343491	01295	1N4002	2	1	
CR4	DIODE, SI, RECT, 1A	343491	01295	1N4002	REF		
CR5	DIODE, SI, RECT. 2A, 50V	347559	05277	1N5400	REF		
F1	FUSE, SLO-BLO, 1/2 AMP	109322	71400	MDL1-2	1	5	
H1	NUT, HEX, DOUBLE CHAMFER, 4-40	184044	73734	8002A-NP	5		
H2	NUT, HEX, 8-32	110544	89536	110544	2		
H3	SCREW, RHF, 4-40 X 1/4	574780	89536	574780	7		
H4	SCREW, FHP, 4-40 X 3/8	493932	89536	493932	2		
H5	SCREW, CAP, 4-40 X 1/2	528307	89536	528307	2		
H6	SCREW, PHP, 6-32 X 1/4	152140	89536	152140	2		
H7	SCREW, PHP, 8-32 X 3/8	114124	89536	114124	2		
H8	SCREW, CAP, 8032 X 3/8 BH	658583	89536	658583	3		
H9	SCREW, PHP, 4-40 X 1/2	601880	89536	601880	1		
H10	WASHER, LOCK, #4	110403	89536	110403	2		
H11	WASHER, LOCK, INT TOOTH #8	110320	89536	110320	2		
H12	WASHER, SHOULDER	436386	89536	436386	7		
J1	CONNECTOR, LINE, W/LINE FILTER	649998	89536	649998	1		
MP1	BRACKET	166322	73734	1552	2		
MP2	HEAT SINK	414128	13103	6030B-TT	1		
MP3	HEAT SINK, POWER SUPPLY	639849	89536	639849	1		

Table 5-5. A4 Power Supply PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
MP4	HEAT SINK, REG.	639864	89536	639864	1		
MP5	INSULATOR, SEMI-CONDUCTOR MOUNTING	508630	55285	7403-09-FR-51	7		
MP6	INSULATOR, GASKET	654467	89536	654467	1		
MP7	INSULATOR, SWITCH	383158	89536	383158	1		
MP8	LABEL, WARNING	386250	89536	386250	2		
MP9	LUG, SOLDER, #4	102558	89536	102558	2		
MP10	NUT PLATE	639807	89536	639807	1		
MP11	SHIELD, POWER SUPPLY	639856	89536	639856	1		
MP12	SUPPORT, HEAT SINK	646208	89536	646208	1		
R1	RES, DEP. CAR, 3.3K +/-5%, 1/4W	348813	80031	CR251-4-5P3K3	1		
R3	RES, DEP. CAR, 390 +/-5%, 1/4W	441543	80031	CR251-4-5P390E	2		
R4	RES, DEP. CAR, 390 +/-5%, 1/4W	441543	80031	CR251-4-5P390E	REF		
R5	RES, VAR, CERMET, 50 +/-20%, 1/2W	320861	02111	62-1-1-500	2		
R6	RES, VAR, CERMET, 50 +/-20%, 1/2W	320861	02111	62-1-1-500	REF		
R7	RES, DEP. CAR, 240 +/-5%, 1/4W	376624	80031	CR251-4-5P240E	1		
R8	RES, DEP. CAR, 2.4K +/-5%, 1/4W	441493	80031	CR251-4-5P2K4	1		
R9	RES, VAR, 500 +/-20%, 1/2W	226068	02111	62-1-1-501	1		
S1	SWITCH, SLIDE, DPDT	234278	89536	234278	2	1	
S2	SWITCH, POWER, DPDT	291526	89536	291526	1	1	
S3	SWITCH, SLIDE, DPDT	234278	89536	234278	REF		
T1	POWER TRANSFORMER, W/HEADER	639815	89536	639815	1		
TP1-TP10	CONNECTOR, TEST POINT	512889	02660	62395	10		
U1	IC, VOLTAGE REGULATOR, +15V	413187	04713	MC7815CT	1	1	
U2	IC, VOLTAGE REGULATOR, -15V	413179	04713	MC7915CP	2	1	
U3	IC, LINEAR, ADJ VOLTAGE REGULATOR	460410	12040	LM317T	1	1	
U4	IC, VOLTAGE REGULATOR, -15V	413179	04713	MC7915CP	REF		
U5	IC, VOLTAGE REGULATOR, +5V	355107	12040	LM340T-5	1	1	
U6	IC, VOLTAGE REGULATOR, +12V	428854	04713	MC7812CT	1	1	
U7	IC, VOLTAGE REGULATOR, -12V	381665	04713	MC7912CP	1	1	
U8	IC, VOLTAGE REGULATOR, +5V	428847	04713	MC7805CT	1	1	
XF1-A	FUSEHOLDER, BODY	375188	89536	375188	1		
XF1	FUSEHOLDER, CAP	460238	89536	460238	1		
XU8	SOCKET, XSTR/IC	402958	27264	10-18-2031	1		

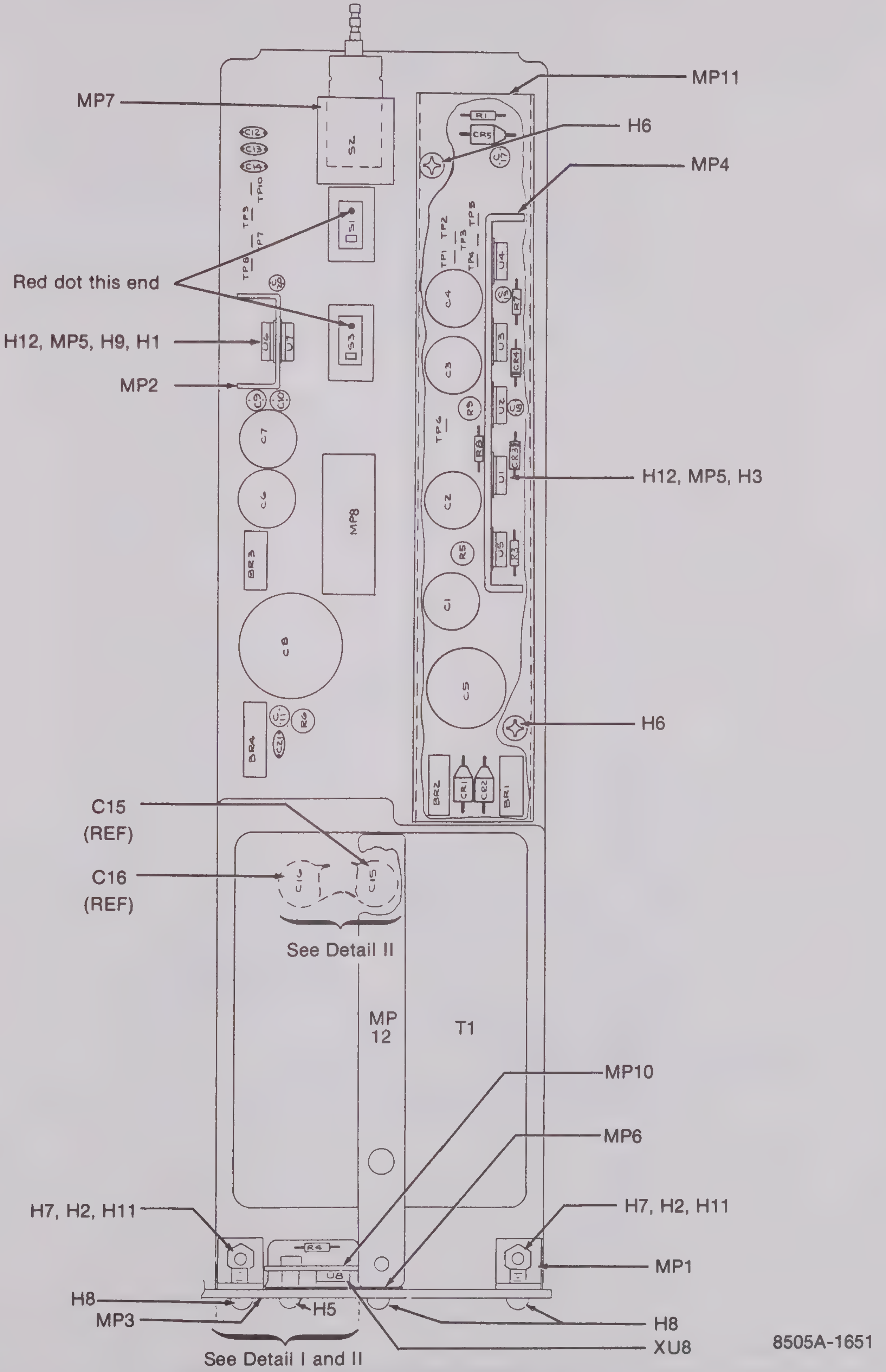
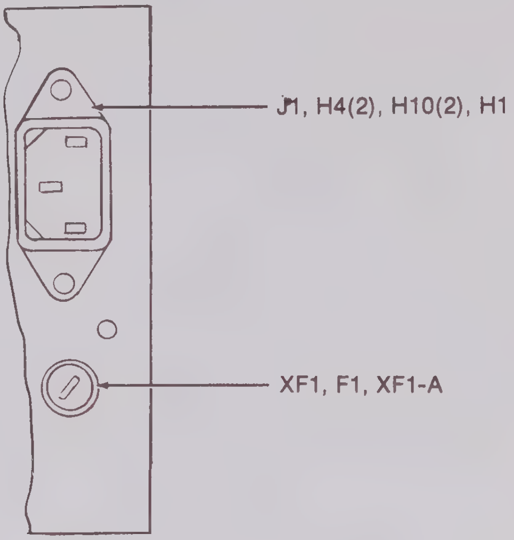
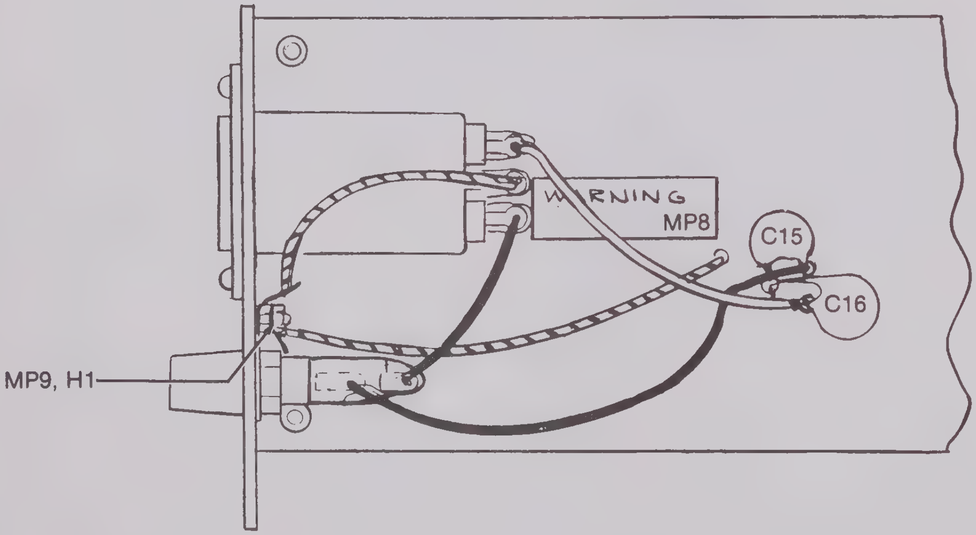

MP11
MP7
H6
MP4
Red dot this end
H12, MP5, H9, H1
MP2
H12, MP5, H3
H6
C15
(REF)
C16
(REF)
See Detail II
MP
12
T1
MP10
MP6
H7, H2, H11
H7, H2, H11
MP1
H8
MP3
H5
H8
XU8
See Detail I and II
8505A-1651
S2
S1
S3
C12
C13
C14
TP8
TP7
TP9
TP10
U6
U7
C9
C10
C7
C6
MP8
BR3
C8
BR4
C11
R6
C21
R1
CR5
C17
TP1
TP2
TP3
TP4
TP5
C4
U4
C19
R7
C3
U3
CR4
R9
U2
C18
TP6
R8
CR3
U1
C2
R5
U5
R3
C1
C5
BR2
CR1
CR2
BR1
C16
C15
R4
U8

Figure 5-5. A4 Power Supply PCB Assembly

Detail I


J1, H4(2), H10(2), H1
XF1, F1, XF1-A

Detail II
(Underside)

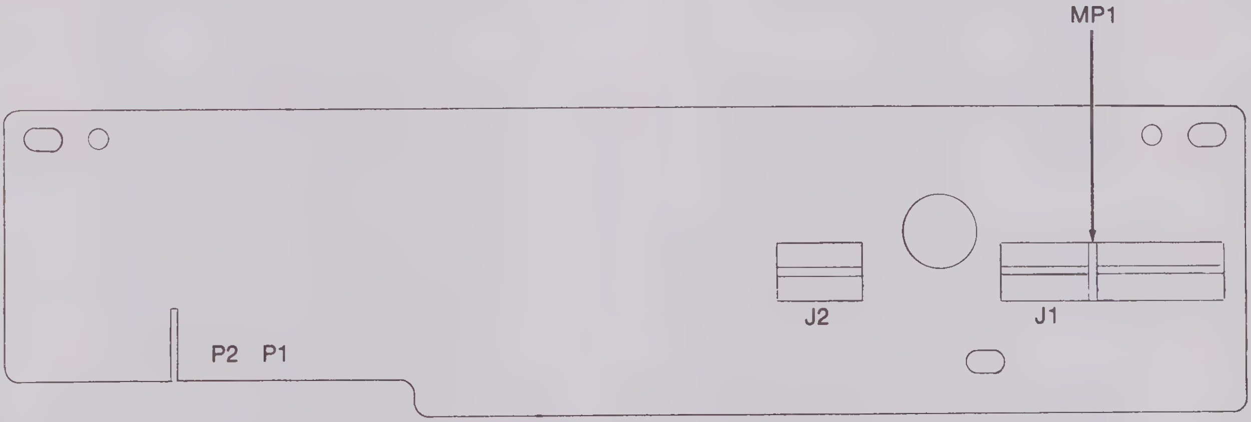

WARNING
MP8
C15
C16
MP9, H1

8505A-4051

Figure 5-5. A4 Power Supply PCB Assembly (cont)

Table 5-6. A5 Power Supply Interconnect Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
A5	POWER SUPPLY INTERCONNECT ASSEMBLY FIGURE 5-6 (8505A-4004)	645960	89536	645960	REF		
J1	CONNECTOR, BD EDGE, RECPT, 14-PIN	352682	00779	583694-2	1		
J2	CONNECTOR, BD EDGE, RECPT, 6-PIN	291625	00779	583650-1	1		
MP1	KEY, CONNECTOR POLARIZING	293498	89536	293498	1		



8505A-4004

Figure 5-6. A5 Power Supply Interconnect Assembly

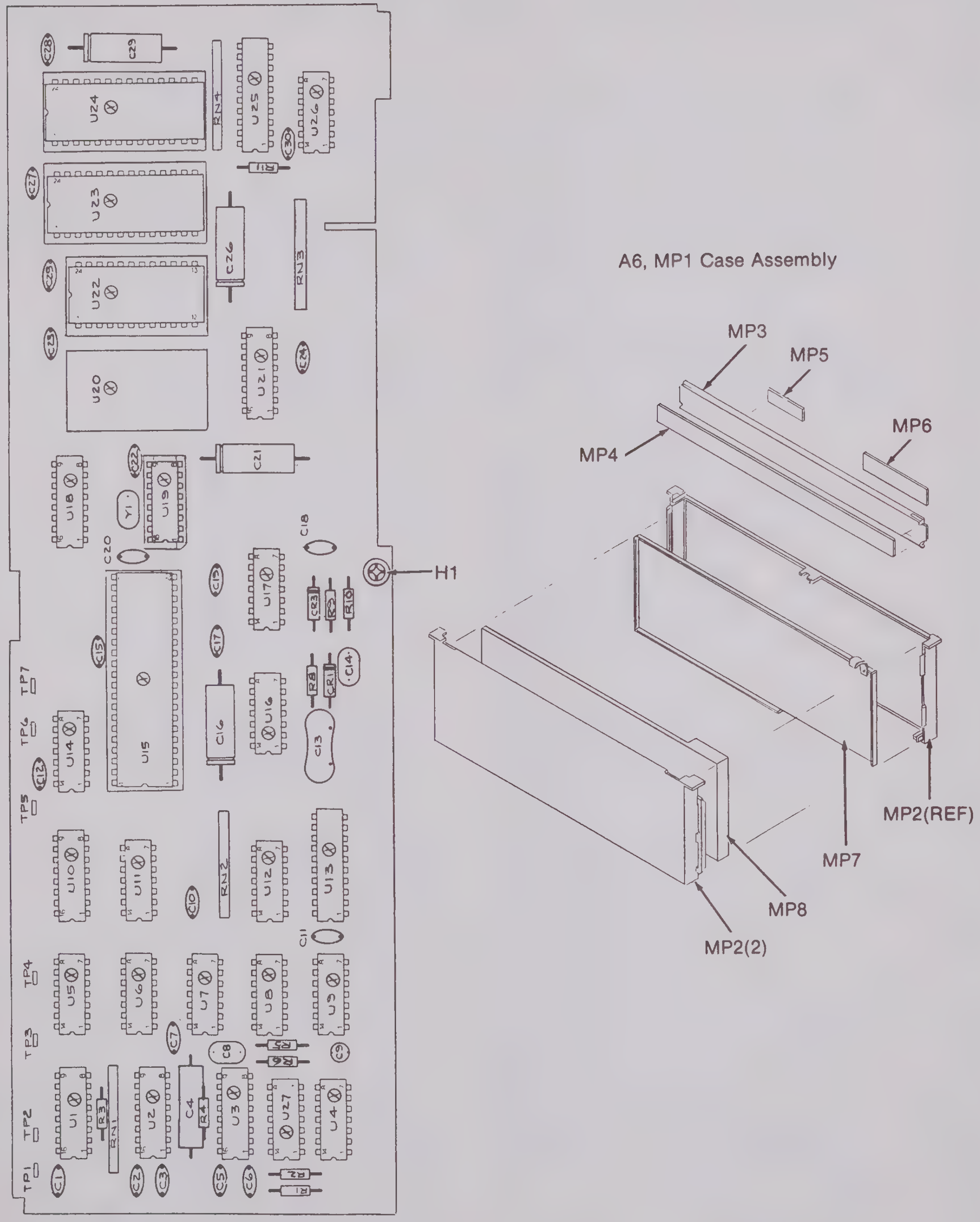
Table 5-7. A6 Controller PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
A6	⊗CONTROLLER PCB ASSEMBLY FIGURE 5-7 (8505A-4187T)	660563	89536	638544	REF		
C1	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CZ30C224M	20		
C2	CAP, CER, 1800 PF +/-5%, 50V	528547	89536	528547	1		
C3	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CZ30C224M	REF		
C4	CAP, FILM, 6.8 UF +/-10%, 35V	182782	56289	150D687X0035	1		
C5	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CZ30C224M	REF		
C6	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CZ30C224M	REF		
C7	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CZ30C224M	REF		
C8	CAP, TA, 39 UF +/-20%, 6V	163915	56289	196D396X0006	1		
C9	CAP, CER, 0.01 UF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	1		
C10	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CZ30C224M	REF		
C11	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CZ30C224M	REF		
C12	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CZ30C224M	REF		
C13	CAP, MICA, 33 PF +/-5%, 500V	160317	02799	DM15E330J	1		
C14	CAP, CER, 2700 PF, GMV, 600V	106211	51406	DD60B1025U272P1KV	1		
C15	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CZ30C224M	REF		
C16	CAP, ELECT, 47 UF +75/-20%, 25V	655191	89536	655191	4		
C17	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CZ30C224M	REF		
C18	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CZ30C224M	REF		
C19	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CZ30C224M	REF		
C20	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CZ30C224M	REF		
C21	CAP, ELECT, 47 UF +75/-20%, 25V	655191	89536	655191	REF		
C22	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CZ30C224M	REF		
C23	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CZ30C224M	REF		
C24	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CZ30C224M	REF		
C25	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CZ30C224M	REF		
C26	CAP, ELECT, 47 UF +75/-20%, 25V	655191	89536	655191	REF		
C27	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CZ30C224M	REF		
C28	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CZ30C224M	REF		
C29	CAP, ELECT, 47 UF +75/-20%, 25V	655191	89536	655191	REF		
C30	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CZ30C224M	REF		
CR1	DIODE, SI, HI SPEED SWITCHING	203323	07910	1N4448	1	1	
CR3	DIODE, ZEN, UNCOMP, 5.1 Vz	535476	04713	1N5231B	REF		
H1	SCREW, PHP, 4-40 X 3/8	256164	89536	256164	1		
MP1	CASE ASSEMBLY (INCLUDES MP2-MP8)	638510	89536	638510	1		1
MP2	CASE HALF	402990	89536	402990	2		
MP3	CASE COVER	402974	89536	402974	1		
MP4	SHIELD, CASE COVER	652172	89536	652172	1		
MP5	DECAL, "CONTROLLER"	640359	89536	640359	1		
MP6	DECAL, "CAUTION"	454504	89536	454504	1		
MP7	GUARD, CASE REAR	383364	89536	383364	1		
MP8	GUARD, CASE FRONT	383356	89536	383356	1		
MP9	SPRING, COIL, 6 - 3/4 (with H1)	424465	83553	C0102-014-0380M	1		
MP10	SPACER, STANDOFF, 4-40 (not shown)	335604	89536	335604	1		
R1	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	2		
R2	RES, DEP. CAR, 620K +/-5%, 1/4W	442509	80031	CR251-4-5P620K	1		

Table 5-7. A6 Controller PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
R3	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	3		
R4	RES, DEP. CAR, 1.5K +/-5%, 1/4W	343418	80031	CR251-4-5P1K5	3		
R5	RES, DEP. CAR, 1.5K +/-5%, 1/4W	343418	80031	CR251-4-5P1K5	REF		
R6	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R8	RES, DEP. CAR, 33K +/-5%, 1/4W	348888	80031	CR251-4-5P33K	1		
R9	RES, DEP. CAR, 1.5K +/-5%, 1/4W	343418	80031	CR251-4-5P1K5	REF		
R10	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R11	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
RN1	NETWORK, RESISTOR, SIP, 6.2K, 10-PIN	501536	91637	MSP10A01622G	3		
RN2	NETWORK, RESISTOR, SIP, 6.2, 10-PIN	501536	91637	MSP10A01622G	REF		
RN3	NETWORK, RESISTOR, SIP, 2K, 10-PIN	446880	91637	446880	1		
RN4	NETWORK, RESISTOR, SIP, 6.2K, 10-PIN	501536	91637	MSP10A01622G	REF		
TP1-TP7	TERMINAL, CONNECTOR	512889	02660	62395	7		
U1	⊘IC, TTL LPS, DUAL J-K F/F	412999	01295	SN74LS109N	1	1	
U2	⊘IC, CMOS, MONOSTABLE MV	454017	04713	MC14538BCP	1	1	
U3	⊘IC, CMOS, DUAL UP COUNTER	355164	04713	MC14520BCP	1	1	
U4	⊘IC, CMOS/MOS, PLL	403584	02735	CD4046AE	1	1	
U5	⊘IC, LSTTL, QUAD 1-INPUT NAND GATE	393033	04713	SN74LS00N	1	1	
U6	⊘IC, LSTTL, TRIPLE 3-INPUT & GATE	393082	07263	74LS11PC	1	1	
U7	⊘IC, CMOS, DUAL D F/F W/SET & RESET	536433	04713	MC4013BCP	2	1	
U8	⊘IC, CMOS, TRIPLE 3-INPUT NOR GATE	586453	04713	MC14025UBCP	2	1	
U9	⊘IC, CMOS, DUAL D F/F/ W/SET & RESET	536433	04713	MC4013BCP	REF		
U10	⊘IC, CMOS, HEX INVERTER	381848	02735	CD4049AE	1	1	
U11	⊘IC, CMOS, TRI 3-INPUT NAND GATES	375147	02735	CD4023UBE	1	1	
U12	⊘IC, LSTTL, QUAD & EDGE TRG D F/F CLR	393215	01295	SN74LS175N	1	1	
U13	⊘IC, LSTTL, OCTL INV DRVR W/ENAB NOT	429480	01295	SN74LS240N	1	1	
U14	⊘IC, CMOS, QUAD 2-INPUT NAND GATE	355198	04713	MC14011UBCP	1	1	
U15	⊘IC, NMOS, 8080A, 8-BIT MICROPROCESSOR	404541	34649	C8080A	1	1	
U16	⊘IC, CMOS, TRIPLE 3-INPUT NOR GATE	586453	04713	MC14025UBCP	REF		
U17	⊘IC, CMOS, QUAD 2-INPUT NOR GATE	355172	02735	CD4001AE	2	1	
U18	⊘IC, TTL MULTIPLEXER	393165	01295	SN74LS139N	1	1	
U19	⊘IC, STTL, 8224/8080 CLOCK GENERATOR	586230	89536	586230	1		
U20	⊘IC, NMOS, 512X8 BIT EEPROM	685545	60395	XD2804A	1	1	
U21	⊘IC, CMOS, 8-BIT PRIORITY ENCODER	412973	02735	CD4532BE	1	1	
U22	⊘IC, NMOS, 2KX8 BIT STATIC ROM	584144	89536	584144	1	1	
U23	⊘IC, PROM, PROGRAMMED, 8505A-4502	660449	89536	660449	1		
U24	⊘IC, PROM, PROGRAMMED, 8505A-4503	660456	89536	660456	1		
U25	⊘IC, CMOS, OCT BUS TRNSCVR EQ TO L3245	535906	36665	MD74C245AC	1	1	
U26	⊘IC, CMOS, QUAD 2-INPUT NOR GATE	355172	02735	CD4001AE	REF		
U27	⊘IC, CMOS, QUAD 2-INPUT NAND GATE	404632	02735	CD4039BE	1	1	
XU15	SOCKET, IC, 40-PIN	429282	91506	340-AG39D	1		
XU19	SOCKET, IC, 16-PIN	276535	91506	316-AG39D	1		
XU20	SOCKET, IC, 24-PIN	376236	91506	324-AG39D	2		
XU22	SOCKET, IC, 24-PIN	376236	91506	324-AG39D	REF		
XU23	SOCKET, IC, 28-PIN	448217	91506	328-AG39D	2		
XU24	SOCKET, IC, 28-PIN	448217	91506	328-AG39D	REF		
Y1	CRYSTAL, QUARTZ	642728	89536	642728	1	1	

1 USE P/N 638510 TO ORDER COMPLETE MODULE CASE ASSY., WITHOUT PCB ASSY.


A6, MP1 Case Assembly
MP3
MP5
MP6
MP4
H1
MP2(REF)
MP7
MP8
MP2(2)
C28
C29
U24
RN4
U25
U26
C30
R11
C27
U23
C26
RN3
C25
U22
C23
U21
C24
U20
C21
C22
U18
Y1
U19
C18
C20
C19
U17
CR3
R9
R10
C15
U15
C17
R8
CR1
C14
TP7
TP6
U14
C16
U16
C13
C12
TP5
U10
U11
RN2
U12
U13
C10
C11
TP4
U5
U6
U7
U8
U9
TP3
C7
C8
R5
R6
C9
TP2
U1
R3
RN1
U2
C4
R4
U3
U27
U4
TP1
C1
C2
C3
C5
C6
R2
R1

CAUTION
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STATIC ELECTRICITY

MIS-1687

Figure 5-7. A6 Controller PCB Assembly

Table 5-8. A7 Front/Rear Switch PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
A7	FRONT/REAR SWITCH PCB ASSEMBLY FIGURE 5-8 (8505A-4005T)	646281	89536	646281	REF		
CR1	DIODE, INFRARED	403238	14936	ME7024	1	1	
E1	VOLTAGE SURGE PROTECTOR	442731	25088	B1-C145	1		
F1	FUSE, 3A, 300V	643833	71400	SC3	4	10	
F2	FUSE, 3A, 300V	643833	71400	SC3	REF		
F3	FUSE, FAST ACTING, 1-1/2 AMP	109330	71400	AGC1 1-2	1	5	
F4	WIRE, MAGNET, #36, SLEEVED	160978	89536	160978	A/R		
F5	FUSE, 3A, 300V	643833	71400	SC3	REF		
F6	FUSE, 3A, 300V	643833	71400	SC3	REF		
H1	SCREW, FHP, 2-56 X 5/8 (w/J1)	370270	89536	370270	4		
H2	WASHER, STAR, EXTERNAL (w/F3)	175943	89536	175943	1		
H3	NUT, PRESS, 2-56	603688	89536	603688	2		
J1	REAR INPUT CABLE ASSEMBY	639609	89536	639609	1		
L1	RESISTOR COIL	438325	89536	438325	1		
L2	CHOKE, COMMON MODE	656629	89536	656629	1		
MP1	PLATE, REAR INPUT	651760	89536	651760	1		
MP2	FUSE HOLDER (w/F3)	375188	89536	375188	1		
MP3	CABLE TIE (w/F1, F2, F5, F6)	172080	89536	172080	8		
MP4	MOUNT, LED (w/CR1)	658161	89536	658161	1		
MP5	CAP, FUSE HOLDER (w/F3)	460238	89536	460238	1		
MP6	CONNECTOR, AMP POST	267500	00779	87022-1	2		
MP7	SPACER, SWAGE, 6-32 X .265	650192	89536	650192	3		
MP8	DECAL, REAR INPUT (not shown)	680751	89536	680751	1		
R1	RES, DEP. CAR, 330 +/-5%, 1/4	368720	80031	CR251-4-5P330E	1		
R2	THERMISTOR, 1K +/-40%	494740	50157	180Q10215	1	1	
R3	RES, MTL. FILM, 30.9K +/-1%, 1/2W	247569	91637	CMF653092F	2		
R4	RES, MTL. FILM, 30.9K +/-1%, 1/2W	247569	91637	CMF653092F	REF		
R5	RES, DEP. CAR, 270 +/-5%, 1/4W	348789	80031	CR251-4-5P270E	1		
S1	SWITCH, PUSHBUTTON, 10 POLE	647149	89536	647149	1		
S2	SWITCH, PUSHBUTTON, 2 POLE	647131	89536	647131	2		
S3	SWITCH, PUSHBUTTON, 2 POLE	647131	89536	647131	REF		
W1	WIRE, TEFLON, RED, #22	115576	89536	115576	A/R		

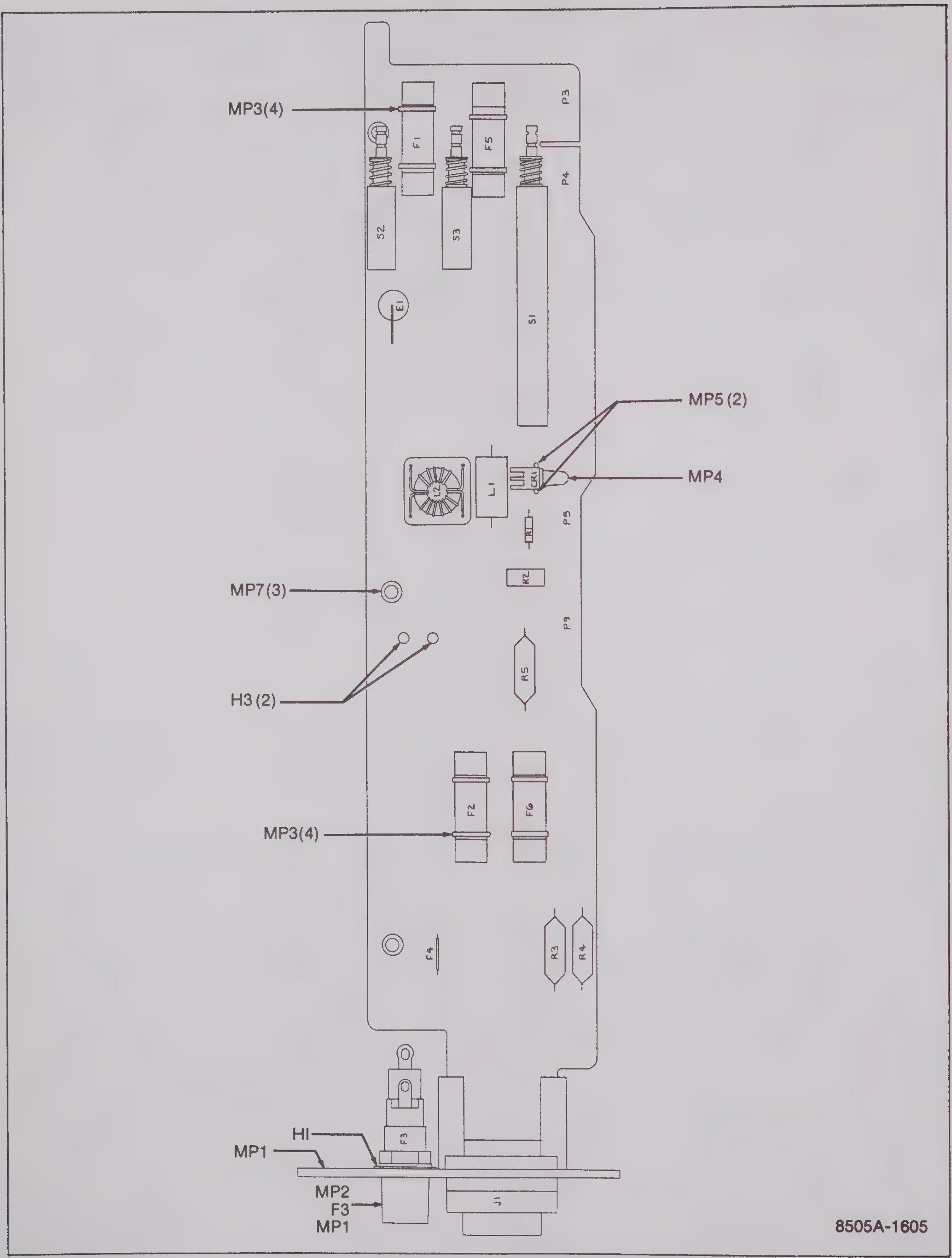

MP3(4)
F1
F5
P3
P4
S2
S3
S1
E1
MP5 (2)
L2
L1
CR1
MP4
P5
R1
R2
MP7(3)
P9
R5
H3 (2)
F2
F6
MP3(4)
F4
R3
R4
F3
HI
MP1
J1
MP2
F3
MP1
8505A-1605

Figure 5-8. A7 Front/Rear Switch PCB Assembly

Table 5-9. A8 DC Signal Conditioner PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
A8	⊘ DC SIGNAL CONDITIONER PCB ASSEMBLY FIGURE 5-9 (8505A-4100T)	646307	89536	646307	REF		
C1	CAP, TA, 5.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	2		
C2	CAP, TA, 5.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	REF		
C3	CAP, CER, 0.22 UF +/-20%, 50V	309849	72982	8131-050-651-220NM	2		
C4	CAP, CER, 0.22 UF +/-20%, 50V	309849	72982	8131-050-651-220NM	REF		
C5	CAP, TA, 30 UF +/-20%, 6V	163915	56289	196D396X0006	1		
C6	CAP, POLY, 0.0047 UF +/-10%, 200V	512830	89536	512830	1		
C10	CAP, ELECT, 6.8 UF -10/+50%, 63V	218966	80031	ET6P8X063A3	2	1	
C11	CAP, ELECT, 6.8 UF -10/+50%, 63V	218966	80031	ET6P8X063A3	REF		
C12	CAP, MICA, 100 PF +/-5%, 500V	148494	02799	DM15F101J	2		
C13	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	1		
C14	CAP, MICA, 100 PF +/-5%, 500V	148494	02799	DM15F101J	REF		
C15	CAP, MICA, 47 PF +/-5%, 500V	148536	02799	DM15E470J	2		
C16	CAP, MICA, 47 PF +/-5%, 500V	148536	02799	DM15E470J	REF		
C18	CAP, CER, 33 PF +/-2%, 100V	354852	80031	2222-638-10339	2		
C19	CAP, CER, 33 PF +/-2%, 100V	354852	80031	2222-638-10339	REF		
CR1	DIODE, HI-SPEED SWITCHING	203323	07910	1N4448	2	1	
CR2	DIODE, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR3	DIODE, ZENER	181073	07910	1N969B	2	1	
CR4	DIODE, ZENER	181073	07910	1N969B	REF		
CR5	DIODE, SI, LOW-CAP, LOW LEAKAGE	348177	07263	FD7223	1	1	
CR6	DIODE, SI, LOW-CAP, LOW LEAKAGE	348177	07263	FD7223	REF		
H1	SCREW, RHP, 4-40 X 3/8	256164	89536	256164	1		
K1	RELAY, ARMATURE	515437	89536	515437	2		
K2	RELAY, ARMATURE	515437	89536	515437	REF		
MP1	CASE ASSEMBLY (INCLUDES MP2-MP9)	458992	89536	458992	1		1
MP2	CASE HALF	402990	89536	402990	REF		
MP3	CASE HALF	402990	89536	402990	REF		
MP4	COVER, CASE	402974	89536	402974	REF		
MP5	SHIELD, COVER	411918	89536	411918	REF		
MP6	DECAL, DC SIGNAL CONDITIONER	413377	89536	413377	1		
MP7	DECAL, CAUTION	454504	89536	454504	REF		
MP8	GUARD, REAR	383364	89536	383364	REF		
MP9	GUARD, FRONT	383356	89536	383356	REF		
MP11	TERMINAL, FEED-THROUGH (not shown)	281865	12615	SL-841-777	1		
MP12	SOCKET, SPRING TYPE (not shown)	343285	00779	2-331272-6	8		
MP14	SPACER, TRANSIPAD (not shown, use w/Q37)	152207	07047	10123-DAP	1		
MP15	SPRING, COIL (not shown)	424465	27745	C0120-014-0380M	1		
MP16	DECAL, DC SIGNAL CONDITIONER (not shown)	651950	89536	651950	REF		
Q1	TRANSISTOR, NPN, SI	330803	07263	MPS6560	2	1	
Q2	TRANSISTOR, PNP, SI	195974	04713	2N3906	6	2	
Q3	TRANSISTOR, NPN, SI	330803	07263	MPS6560	REF		
Q4	TRANSISTOR, PNP, SI	195974	04713	2N3906	REF		

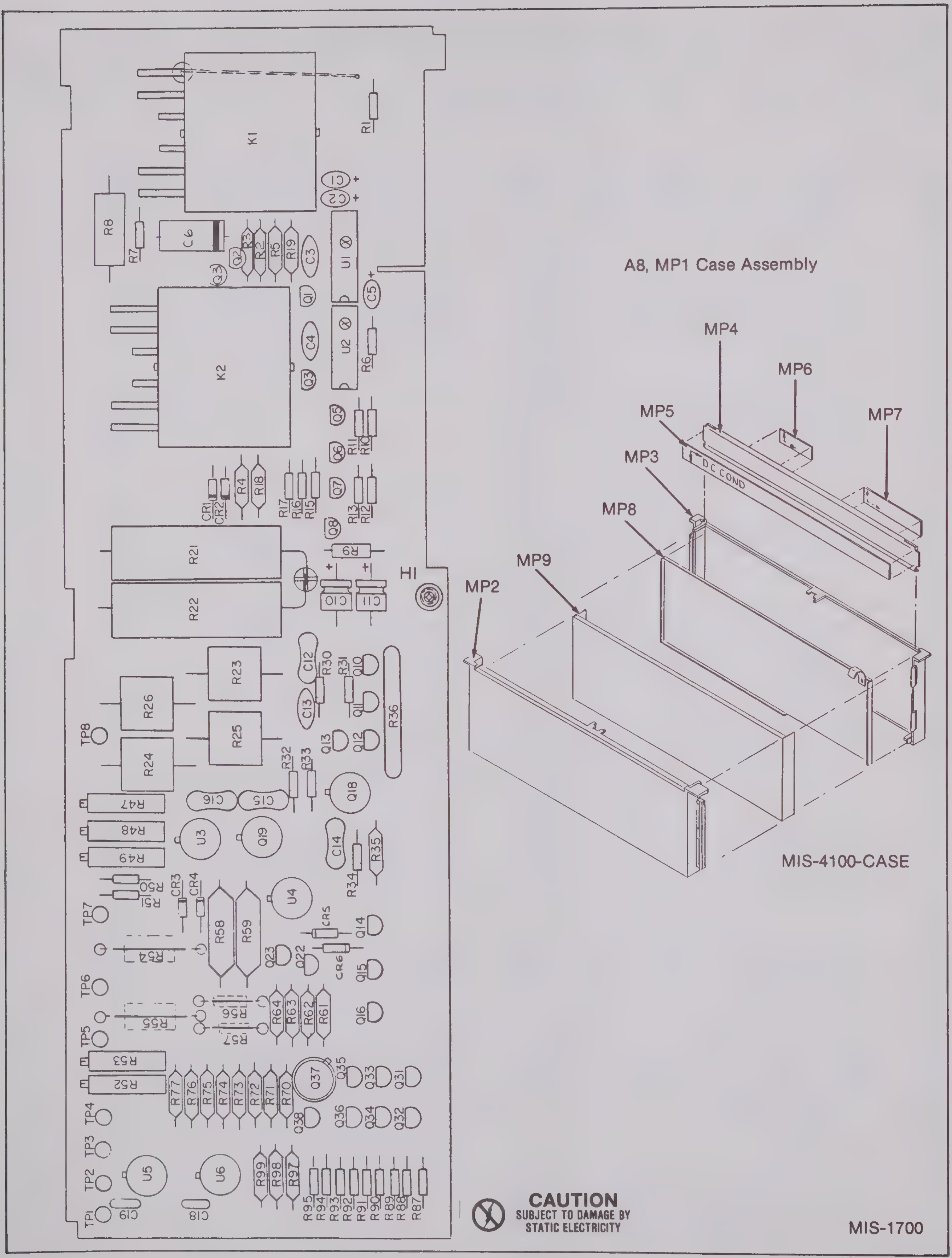
Table 5-9. A8 DC Signal Conditioner PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
Q5	TRANSISTOR, PNP, SI	226290	04713	MPS3640	1	1	
Q6	TRANSISTOR, PNP, SI	195974	04713	2N3906	REF		
Q7	TRANSISTOR, NPN, SI	218396	04713	2N3904	11	3	
Q8	TRANSISTOR, FET,. N-CHANNEL	393314	89536	393314	4	1	
Q10	TRANSISTOR, NPN, SI	218396	04713	2N3904	REF		
Q11	TRANSISTOR, NPN, SI	218396	04713	2N3904	REF		
Q12	TRANSISTOR, NPN, SI	218396	04713	2N3904	REF		
Q13	TRANSISTOR, NPN, SI	218396	04713	2N3904	REF		
Q14	TRANSISTOR, FET,. N-CHANNEL	393314	89536	393314	REF		
Q15	TRANSISTOR, FET,. N-CHANNEL	393314	89536	393314	REF		
Q16	TRANSISTOR, FET,. N-CHANNEL	393314	89536	393314	REF		
Q18	TRANSISTOR, NPN, SI	585109	89536	585109	1	1	
Q19	TRANSISTOR, NPN, SI	295717	24355	AD811-00/17	1	1	
Q22	TRANSISTOR, NPN, SI	218396	04713	2N3904	REF		
Q23	TRANSISTOR, NPN, SI	218396	04713	2N3904	REF		
Q31	TRANSISTOR, PNP, SI	195974	04713	2N3906	REF		
Q32	TRANSISTOR, NPN, SI	218396	04713	2N3904	REF		
Q33	TRANSISTOR, PNP, SI	195974	04713	2N3906	REF		
Q34	TRANSISTOR, NPN, SI	218396	04713	2N3904	REF		
Q35	TRANSISTOR, PNP, SI	195974	04713	2N3906	REF		
Q36	TRANSISTOR, NPN, SI	218396	04713	2N3904	REF		
Q37	TRANSISTOR, PNP, SI	218388	07263	PN3645	1	1	
Q38	TRANSISTOR, NPN, SI	218396	04713	2N3904	REF		
R1	RES, DEP. CAR, 330 +/-5%, 1/4W	368720	80031	CR251-4-5P330E	1		
R2	RES, MTL. FILM, 28.0K +/-1%, 1/8W	291385	91637	CMF552802F	2		
R3	RES, MTL. FILM, 28.0K +/-1%, 1/8W	291385	91637	CMF552802F	REF		
R4	RES, MTL. FILM, 21K +/-1%, 1/8W	441212	91637	CMF552102F	2		
R5	RES, MTL. FILM, 17.8K +/-1%, 1/8W	349183	91637	CMF551782F	2		
R6	RES, DEP. CAR, 470 +/-5%, 1/4W	343434	80031	CR251-4-5P470E	1		
R7	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	5		
R8	RES, COMP, 150K +/-5%, 2W	110122	01121	HB1545	1		
R9	RES, COMP, 150K +/-10%, 1/2W	108167	01121	EB15415	1		
R10	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	1		
R11	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K	1		
R12	RES, DEP. CAR, 15 +/-5%, 1/4W	348755	80031	CR251-4-5P15E	2		
R13	RES, DEP. CAR, 15 +/-5%, 1/4W	348755	80031	CR251-4-5P15E	REF		
R15	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	4		
R16	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	8		
R17	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R18	RES, MTL. FILM, 21K +/-1%, 1/8W	441212	91637	CMF552102F	REF		
R19	RES, MTL. FILM, 17.8K +/-1%, 1/8W	349183	91637	CMF551782F	REF		
R21	RES, DIVIDER SET	434605	89536	434605	1	1	
R22	(PART OF R21 SET)				REF		
R23	(PART OF R21 SET)				REF		
R24	RES, DC RANGE SET	648212	89536	648212	1	1	
R25	(PART OF R24 SET)				REF		
R26	(PART OF R24 SET)				REF		
R30	RES, DEP. CAR, 15K +/-5%, 1/4W	348854	80031	CR251-4-5P15K	1		
R31	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R32	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		

Table 5-9. A8 DC Signal Conditioner PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
R33	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R34	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R35	RES, MTL. FILM, 1M +/-1%, 1/8W	268797	91637	CMF551004F	2		
R36	RES, CERMET, 100M +/-10%, 1W	441758	89536	441758	1		
R47	RES, VAR, CERMET, 200 +/-20%, 1/2W	284711	71450	190PC201B	1		
R48	RES, VAR, CERMET, 50 +/-20%. 1/2W	267815	71450	190PC500B	2		
R49	RES, VAR, CERMET, 50 +/-20%. 1/2W	267815	71450	190PC500B	REF		
R50	RES, DEP. CAR, 2.2 +/-5%, 1/4W	354944	80031	CR251-4-5P2E2	1		
R51	RES, DEP. CAR, 20 +/-5%, 1/4W	442202	80031	CR251-4-5P20E	1		
R52	RES, VAR, CERMET, 100K +/-20%. 1/2W	268581	71450	190PC104B	1		
R53	RES, VAR, CERMET, 10K +/-20%, 1/2W	267880	71450	190PC103B	1		
R54	RES, SELECTED, DURING TEST				4		
R55	RES, SELECTED, DURING TEST				REF		
R56	RES, SELECTED, DURING TEST				REF		
R57	RES, SELECTED, DURING TEST				REF		
R58	RES, SET, MATCHED	290320	89536	290320	1	1	
R59	(PART OF R58 SET)				REF		
R61	RES, MTL. FILM, 86.6K +/-1%, 1/8W	291468	91637	CMF558662F	1		
R62	RES, MTL. FILM, 1M +/-1%, 1/8W	268797	91637	CMF551004F	REF		
R63	RES, MTL. FILM, 1.87K +/-1%, 1/8W	267229	91637	CMF551871F	1		
R64	RES, MTL. FILM, 1K +/-1%, 1/8W	168229	91637	CMF551001F	1		
R70	RES, MTL. FILM, 52.3K +/-1%, 1/8W	237248	91637	CMF555232	1		
R71	RES, MTL. FILM, 3.01K +/-1%, 1/8W	312645	91637	CMF553011F	1		
R72	RES, MTL. FILM, 3.65K +/-1%, 1/8W	293779	91637	CMF553651F	2		
R73	RES, MTL. FILM, 100K +/-1%, 1/8W	248807	91637	CMF551003F	4		
R74	RES, MTL. FILM, 100K +/-1%, 1/8W	248807	91637	CMF551003F	REF		
R75	RES, MTL. FILM, 100K +/-1%, 1/8W	248807	91637	CMF551003F	REF		
R76	RES, MTL. FILM, 4.02 +/-1%, 1/8W	235325	91637	CMF554021F	1		
R77	RES, MTL. FILM, 200K +/-1%, 1/8W	261701	91637	CMF552003F	1		
R87	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R88	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R89	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R90	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R91	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R92	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R93	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R94	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R95	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R97	RES, MTL. FILM, 3.65K +/-1%, 1/8W	293779	91637	CMF553651F	REF		
R98	RES, MTL. FILM, 2.15K +/-1%, 1/8W	293712	91637	CMF552151F	1		
R99	RES, MTL. FILM, 100K +/-1%, 1/8W	248807	91637	CMF551003F	REF		
U1	⊘IC, COS/MOS, QUAD CLOCKED D LATCH	355149	02735	CD4042BE	1	1	
U2	⊘IC, C-MOS, TRIPLE 3 INPUT NAND GATES	375147	02735	CD4023UBE	1	1	
U3	IC, OP AMP, J-FET	680439	12040	LM11CLH	2	1	
U4	IC, OP AMP, J-FET	680439	12040	LM11CLH	REF		
U5	IC, OP AMP	271502	12040	LM301A	2	1	
U6	IC, OP AMP	271502	12040	LM301A	REF		

1 USE P/N 458992 TO ORDER COMPLETE
MODULE CASE ASSY., WITHOUT PCB ASSY.


A8, MP1 Case Assembly
MP4
MP6
MP5
MP7
MP3
MP8
MP9
MP2
DC COND
MIS-4100-CASE
H1
K1
K2
R1
C1
C2
R8
R7
C6
R3
R2
R5
R19
C3
U1
Q2
Q3
Q1
C5
C4
U2
R6
Q5
R11
R10
Q6
Q7
R4
R18
CR1
CR2
R17
R16
R15
R13
R12
Q8
R9
R21
R22
C10
C11
R23
R26
R25
R24
C12
R30
R31
Q10
C13
Q11
R36
Q13
Q12
R32
R33
TP8
R47
R48
R49
C16
C15
Q18
U3
Q19
C14
R35
R34
R50
R51
CR3
CR4
U4
TP7
CR5
Q14
R54
R58
R59
Q23
Q22
CR6
Q15
TP6
R55
R56
R57
R64
R63
R62
R61
Q16
TP5
R53
R52
R77
R76
R75
R74
R73
R72
R71
R70
Q37
Q35
Q33
Q31
TP4
Q38
Q36
Q34
Q32
TP3
TP2
TP1
U5
U6
C19
C18
R99
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CAUTION
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MIS-1700

Figure 5-9. A8 DC Signal Conditioner PCB Assembly

Table 5-10. A9 Active Filter PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
A9	⊘ ACTIVE FILTER PCB ASSEMBLY FIGURE 5-10 (MIS-4130T)	383976	89536	383976	REF		
C1	CAP, FILM, 0.047 UF +/-10%, 50V	413228	89536	413228	3		
C2	CAP, FILM, 0.047 UF +/-10%, 50V	413228	89536	413228	REF		
C3	CAP, FILM, 0.047 UF +/-10%, 50V	413228	89536	413228	REF		
C4	CAP, MICA, 33 PF +/-5%, 500V	160317	02799	DM15E330J	4		
C5	CAP, FILM, 0.47 UF +/-10%, 50V	363085	89536	363085	3		
C6	CAP, FILM, 0.47 UF +/-10%, 50V	363085	89536	363085	REF		
C7	CAP, FILM, 0.47 UF +/-10%, 50V	363085	89536	363085	REF		
C8	CAP, MICA, 33 PF +/-5%, 500V	160317	02799	DM15E330J	REF		
C9	CAP, MICA, 33 PF +/-5%, 500V	160317	02799	DM15E330J	REF		
C10	CAP, MICA, 33 PF +/-5%, 500V	160317	02799	DM15E330J	REF		
C11	CAP, ELECT, 6.8 UF -10/+50%, 63V	218966	73445	ET6P8X063A3	2		
C12	CAP, ELECT, 10 UF -10/+50%, 25V	170266	73445	ET100X025A2	2		
C13	CAP, ELECT, 10 UF -10/+50%, 25V	170266	73445	ET100X025A2	REF		
C14	CAP, ELECT, 6.8 UF -10/+50%, 63V	218966	73445	ET6P8X063A3	REF		
C15	CAP, FILM, 0.0022 UF +/-10%, 200V	442632	89536	442632	1		
CR1	DIODE, ZEN, UNCOMP, +/-50%, 6.8V, 400MW	260695	07910	1N754A	1	1	
CR2	DIODE, ZEN, UNCOMP, +/-50%, 9.1V, 400MW	386557	04713	1N960B	1	1	
CR3	DIODE, SI, HI SPEED SWITCHING	203323	07910	1N4448	1	1	
H1	SCREW, PHP, 4-40 X 3/8 (not shown)	256164	89536	256164	1		
MP1	MODULE CASE ASSEMBLY (MP2-MP9)	458976	89536	458976	1		1
	CASE HALF	402990	89536	402990	2		
MP3	CASE HALF	402990	89536	402990	REF		
MP4	COVER, CASE	402794	89536	402794	1		
MP5	SHIELD, COVER	411959	89536	411959	1		
MP6	DECAL, ACTIVE FILTER ASSEMBLY	413443	89536	413443	1		
MP7	DECAL, CAUTION	454504	89536	454504	1		
MP8	GUARD, REAR	383364	89536	383364	1		
MP9	GUARD, FRONT	383356	89536	383356	1		
MP10	SPACER, XSTR (W/Q26)	152207	07047	10123DAP	1		
MP11	SPACER, PCB (not shown)	335604	89536	335604	1		
MP12	SPRING, COIL (not shown)	424465	83553	C0120-014-0380M	1		
Q1	TRANSISTOR, SI, PNP	195974	04713	2N3906	6	2	
Q2	TRANSISTOR, SI, NPN	218396	04713	2N3904	9	2	
Q3	TRANSISTOR, SI, PNP	195974	04713	2N3906	REF		
Q4	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q5	TRANSISTOR, SI, PNP	195974	04713	2N3906	REF		
Q6	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q7	TRANSISTOR, SI, PNP	195974	04713	2N3906	REF		
Q8	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q9	TRANSISTOR, SI, PNP	195974	04713	2N3906	REF		
Q10	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q11	TRANSISTOR, SI, PNP	195974	04713	2N3906	REF		
Q12	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		

Table 5-10. A9 Active Filter PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
Q13	TRANSISTOR, SI, PNP	226290	04713	MPS3640	1	1	
Q14-Q25	TRANSISTOR, N-CHAN, FIELD EFFECT (FET)	393314	89536	393314	15	3	
Q26	TRANSISTOR, SI, PNP	218388	07263	2N3645	1	1	
Q27	TRANSISTOR, SI, NPN	284075	32293	ITS1099	1	1	
Q28	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q29	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q30	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q31	TRANSISTOR, N-CHAN, FIELD EFFECT (FET)	393314	89536	393314	REF		
Q32	TRANSISTOR, N-CHAN, FIELD EFFECT (FET)	393314	89536	393314	REF		
Q33	TRANSISTOR, N-CHAN, FIELD EFFECT (FET)	393314	89536	393314	REF		
R1	RES, DEP. CAR, 6.2K +/-5%, 1/4W	442368	80031	CR251-4-5P6K2	1		
R2	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	1		
R3	RES, MTL. FILM, 51.1K +/-5%, 1/8W	289553	91637	CMF555112F	1		
R4	RES, DEP, CAR, 8.2K +/-5%, 1/4W	441675	80031	CR251-4-5P8K2	2		
R5	RES, DEP, CAR, 8.2K +/-5%, 1/4W	441675	80031	CR251-4-5P8K2	REF		
R8-R11	RES, MTL. FILM, 45.3K +/-1%, 1/8W	234971	91637	CMF554532F	4		
R12	RES, MTL. FILM, 12.1K +/-1%, 1/8W	234997	91637	CMF551212F	3		
R13	RES, MTL. FILM, 4.87K +/-1%, 1/8W	294850	91637	CMF554871F	1		
R14	RES, VAR, CERMET, 20K +/-10%, 1/2W	291609	89536	291609	1		
R15	RES, MTL FILM (SELECTED)				1		2
R16	RES, MTL FILM (SELECTED)				1		2
R17	RES, MTL. FILM, 1M +/-1%, 1/2W	327510	91637	CMF651004F	2		
R18	RES, MTL. FILM, 1M +/-1%, 1/2W	327510	91637	CMF651004F	REF		
R19	RES, MTL. FILM, 12.1K +/-1%, 1/8W	234997	91637	CMF551212F	REF		
R20	RES, MTL. FILM, 249K +/-1%, 1/8W	268805	91637	CMF552493F	2		
R21	RES, MTL. FILM, 57.6K +/-1%, 1/8W	289116	91637	CMF555762F	1		
R22	RES, MTL. FILM, 12.1K +/-1%, 1/8W	234997	91637	CMF551212F	REF		
R23	RES, MTL. FILM, 249K +/-1%, 1/8W	268805	91637	CMF552493F	REF		
R24	RES, DEP. CAR, 15 +/-5%, 1/4W	348755	80031	CR251-4-5P15E	2		
R25	RES, DEP. CAR, 100 +/-5%, 1/4W	348771	80031	CR251-4-5P100E	2		
R26	RES, DEP. CAR, 100 +/-5%, 1/4W	348771	80031	CR251-4-5P100E	REF		
R27	RES, DEP. CAR, 15 +/-5%, 1/4W	348755	80031	CR251-4-5P15E	REF		
R28	RES, MTL. FILM, 26.7K +/-1%, 1/8W	245779	91637	CMF552672F	2		
R29	RES, MTL. FILM, 26.7K +/-1%, 1/8W	245779	91637	CMF552672F	REF		
TP1-TP4	TERMINAL, TEST POINT	179283	89536	179283	4		
U1	⊘IC, CMOS, HEX D FLIP FLOP	404509	12040	MM74C174N	1	1	
U2	⊘IC, CMOS, TRIPLE 3-INPUT NAND GATES	375147	C2735	CD4023UBE	1	1	
U3	IC, LIN, OPERATIONAL AMPLIFIER	363515	12040	LM301AN	2	1	
U4	IC, LIN, OPERATIONAL AMPLIFIER	363515	12040	LM301AN	REF		
U5	IC, LIN, OPERATIONAL AMPLIFIER	392902	12040	LM1436H	1	1	
U6	NETWORK, 100K +/-5% 1/4W, 16-P DUAL THRU	404749	89536	404749	1		
U7	NETWORK, 100K +/-5% 1/4W, 16-P THROUGH	380618	89536	380618	1		
XR15,16	SOCKET, RESISTOR	343285	00779	2-331272-6	4		
	1 USE P/N 458976 TO ORDER CASE WITHOUT PCB ASSEMBLY.						
	2 R15 AND R16 ARE SELECTED DURING TEST						

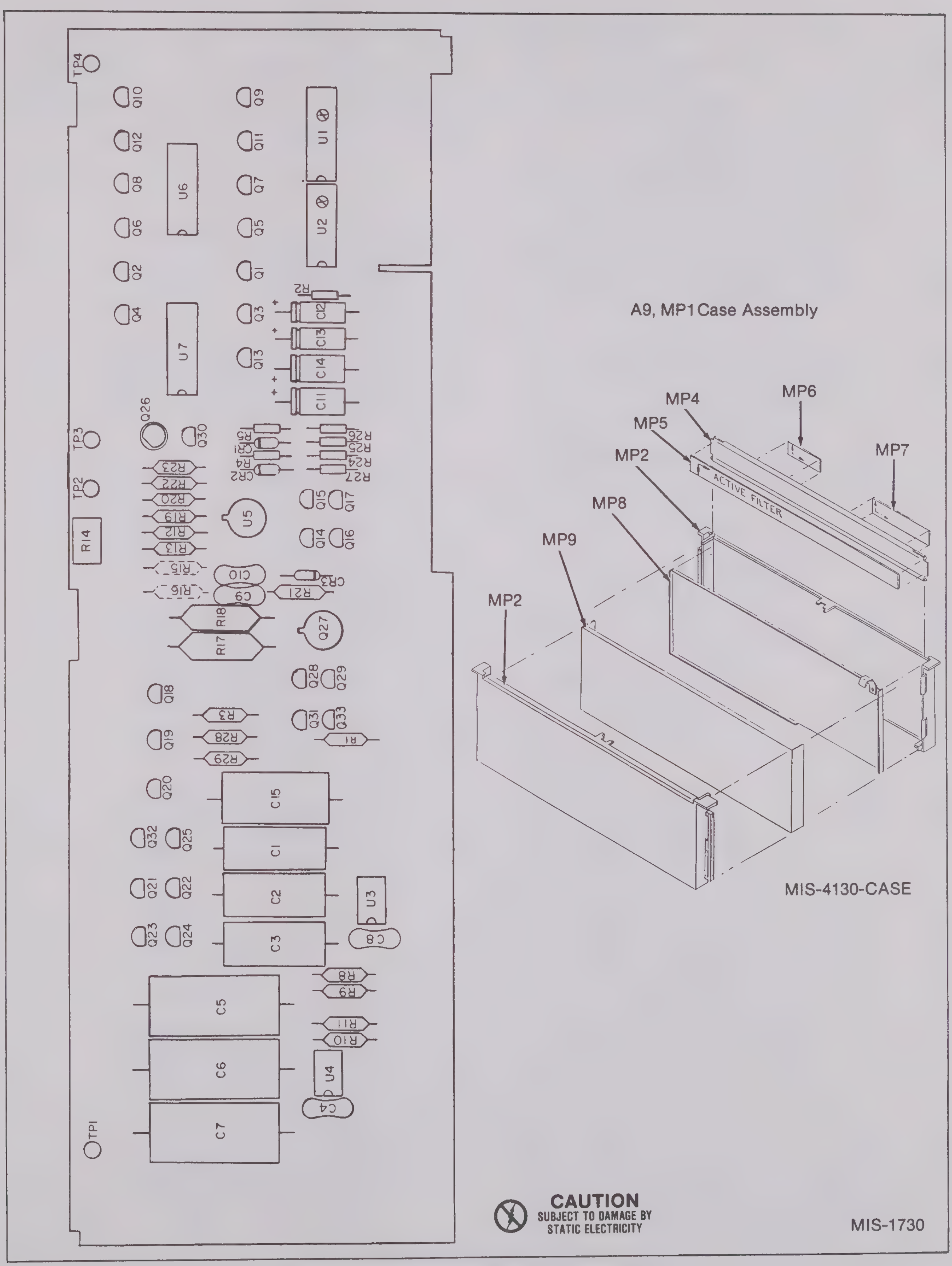

TP4
Q10
Q9
U1
Q12
Q11
U6
Q8
Q7
Q6
Q5
U2
Q2
Q1
R2
Q4
Q3
C12
U7
C13
Q13
C14
C11
Q26
Q30
TP3
R5
CR1
R4
CR2
R26
R25
R24
R27
R23
R22
R20
R19
R12
R13
R15
R16
TP2
U5
Q15
Q17
Q14
Q16
R14
C10
C9
CR3
R21
R18
R17
Q27
Q28
Q29
Q18
R3
Q31
Q33
R28
R1
Q19
R29
Q20
C15
Q32
Q25
C1
Q21
Q22
C2
U3
Q23
Q24
C3
C8
R8
R9
C5
R11
R10
C6
U4
C4
TP1
C7
A9, MP1 Case Assembly
MP4
MP6
MP5
MP2
MP7
ACTIVE FILTER
MP8
MP9
MP2
MIS-4130-CASE
CAUTION
SUBJECT TO DAMAGE BY
STATIC ELECTRICITY
MIS-1730

Figure 5-10. A9 Active Filter PCB Assembly

Table 5-11. A10 Fast R2 A/D Converter Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
A10	⊗FAST R2 A/D CONVERTER ASSEMBLY FIGURE 5-11 (MIS-4140T)	383984	89536	383984	REF		
A10A1	A/D ANANLOG PCB ASSEMBLY				1		
A10A2	⊗A/D DIGITAL PCB ASSEMBLY				1		
MP1	CASE ASSY (INCLUDES MP2-MP9)	458968	89536	458968	1		1
MP2	CASE HALF	402990	89536	402990	REF		
MP3	CASE HALF, MODIFIED	402982	89536	402982	REF		
MP4	COVER, CASE	402974	89536	402974	REF		
MP5	SHIELD, COVER	411967	89536	411967	REF		
MP6	DECAL, FAST RR CONVERTER ASSY	413450	89536	413450	REF		
MP7	DECAL, CAUTION	454504	89536	454504	REF		
MP8	GUARD, REAR	383364	89536	383364	REF		
MP9	GUARD, FRONT	383315	89536	383315	REF		
	1 USE P/N 458968 TO ORDER COMPLETE MODULE CASE WITHOUT THE PCB'S.						

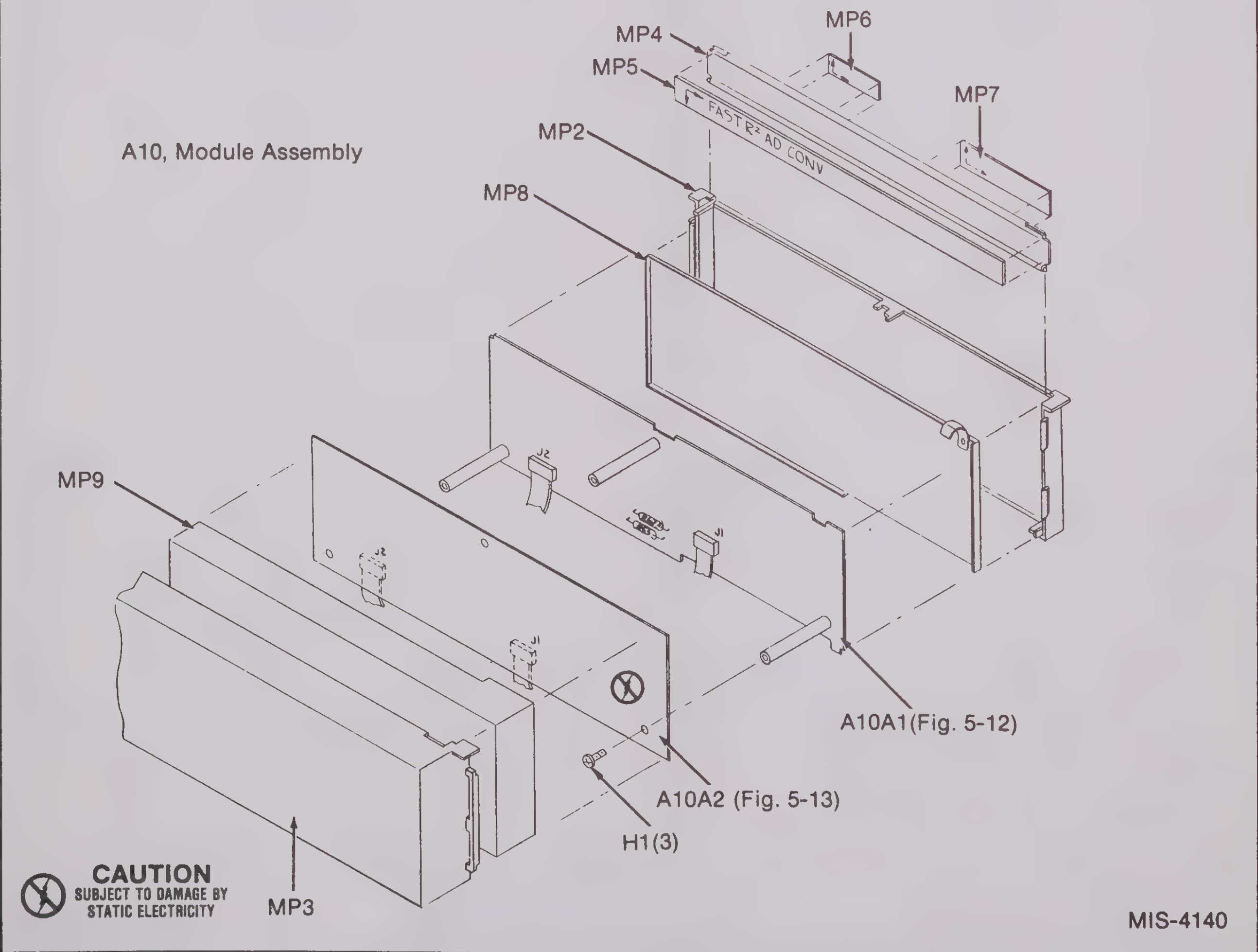

MP4
MP6
MP5
MP7
FAST R² AD CONV
MP2
A10, Module Assembly
MP8
J2
J1
MP9
J2
J1
A10A1(Fig. 5-12)
A10A2 (Fig. 5-13)
H1(3)
CAUTION
SUBJECT TO DAMAGE BY
STATIC ELECTRICITY
MP3
MIS-4140

Figure 5-11. A10 Fast R2 A/D Converter Assembly

Table 5-12. A10A1 A/D Analog PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
A10A1	A/D ANALOG PCB ASSEMBLY FIGURE 5-12 (MIS-4140)	383752	89536	383752	REF		
C1	CAP, TA, 10 UF +/-20%, 35V	417683	56289	196D106X0035KA1	2		
C2	CAP, TA, 10 UF +/-20%, 35V	417683	56289	196D106X0035KA1	REF		
C3	CAP, MICA, 33 PF +/-5%, 500V	160317	72136	DM15E330J	1		
C4	CAP, MICA, 30 PF +/-5%, 500V	340570	72136	DM15E300J	1		
C5	CAP, FILM, 0.22 UF +/-10%, 80V	159392	56289	192P2249R8	1		
C6	CAP, TA, 4.7 UF +/-20%, 25V	161943	56289	196D475X0025KA1	1		
C7	CAP, MICA, 150 PF +/-5%, 500V	148478	72136	DM15F151J	2		
C8	CAP, MICA, 150 PF +/-5%, 500V	148478	72136	DM15F151J	REF		
C9	CAP, POLYST, 0.047 UF +/-10%, 100V	260562	84411	863UW47391	2		
C10	CAP, POLYST, 0.047 UF +/-10%, 100V	260562	84411	863UW47391	REF		
C11	CAP, MICA, 47 PF +/-5%, 500V	148536	72136	DM15E470J	3		
C12	CAP, MICA, 47 PF +/-5%, 500V	148536	72136	DM15E470J	REF		
C13	CAP, ELECT, 470 UF -10/+50%, 6.3V	187773	80031	ET471X6P3A6	1		
C14	CAP, MICA, 47 PF +/-5%, 500V	148536	72136	DM15E470J	REF		
C15	CAP, CER, 0.0047 UF +/-10%, 500V	106724	71590	CF-472	1		
C16	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	4		
C17	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C18	CAP, TA, 68 UF +/-20%, 25V	446450	56289	196D686X0025TE4	1		
C20	CAP, TA, 0.22 UF +/-20%, 35V	161331	56289	196D224X0035HA1	1		
C21	CAP, MICA, 1800 PF +/-5%, 500V	148353	72136	DM19F182J	1		
C22	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C23	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
CR1	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	2	1	
CR3	DIODE, SI LO-CAP, LO-LEAK	348177	07263	FD7223	4	1	
CR4	DIODE, SI LO-CAP, LO-LEAK	348177	07263	FD7223	REF		
CR5	DIODE, SI, CONTROLLER FWD VOL	234468	07910	TD9039	2	1	
CR6	DIODE, SI, CONTROLLER FWD VOL	234468	07910	TD9039	REF		
CR7	DIODE, SI LO-CAP, LO-LEAK	348177	07263	FD7223	REF		
CR8	DIODE, SI LO-CAP, LO-LEAK	348177	07263	FD7223	REF		
CR9	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
H1	SCREW, PHP, 4-40 X 1/4	256165	89536	256165	3		
H2	SCREW, RHP, 4-40 X 3/8	256164	89536	256164	1		
J1	SOCKET, IC	276535	91506	316-AG39D	2		
J2	SOCKET, IC	276535	91506	316-AG39D	REF		
MP1	SOCKET, COMP. LEAD (TO R55, R67)	343285	00779	2-331272-6	4		
MP2	SPRING, COIL (not shown)	424465	83553	C0120-014-0380	1		
MP3	SPACER, ROUND (not shown)	417881	89536	417881	3		
MP4	SPACER, ROUND (not shown)	335604	89536	335604	1		
Q1	TRANSISTOR, FET (SELECTED)	256487	89536	256487	1	1	
Q2	TRANSISTOR, FET (SELECTED)	256487	89536	256487	REF		
Q3	TRANSISTOR, FET (SELECTED)	256487	89536	256487	REF		
Q4	TRANSISTOR, FET, N-CHANNEL	343830	89536	343830	5	1	
Q5	TRANSISTOR, FET, N-CHANNEL	343830	89536	343830	REF		
Q6	TRANSISTOR, FET, N-CHANNEL	343830	89536	343830	REF		

Table 5-12. A10A1 A/D Analog PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
Q7	TRANSISTOR, FET, N-CHANNEL	343830	89536	343830	REF		
Q8	TRANSISTOR, FET, N-CHANNEL	343830	89536	343830	REF		
Q9	TRANSISTOR, FET, DUAL, N-CHANNEL	376087	89536	376087	2	1	
Q10	TRANSISTOR, SI, NPN	218396	04713	2N3904	1	1	
Q11	TRANSISTOR, FET (SELECTED)	256487	89536	256487	REF		
Q12	TRANSISTOR, FET (SELECTED)	256487	89536	256487	REF		
Q13	TRANSISTOR, FET (SELECTED)	256487	89536	256487	REF		
Q14	TRANSISTOR, FET (SELECTED)	256487	89536	256487	REF		
Q15	TRANSISTOR, FET (SELECTED)	256487	89536	256487	REF		
Q16	TRANSISTOR, FET (SELECTED)	256487	89536	256487	REF		
Q17	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578	12	3	
Q18	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578	REF		
Q19	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578	REF		
Q20	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578	REF		
Q21	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578	REF		
Q22	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578	REF		
Q23	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578	REF		
Q24	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578	REF		
Q25	TRANSISTOR, FET (SELECTED)	256487	89536	256487	REF		
Q26	TRANSISTOR, FET (SELECTED)	256487	89536	256487	REF		
Q27	TRANSISTOR, FET, DUAL, N-CHANNEL	376087	89536	376087	REF		
Q28	TRANSISTOR, SI, PNP	195974	04713	2N3906	1	1	
Q29	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578	REF		
Q30	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578	REF		
Q31	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578	REF		
Q32	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578	REF		
R1	RES, VAR, CERMET, 500 +/-20%, 1/2W	267849	75378	190PC501B	1		
R2	RES, VAR, CERMET, 10 +/-20%, 1/2W	344135	75378	190PC100B	2		
R3	RES, VAR, CERMET, 500 +/-10%, 1/2W	291120	89536	291120	1		
R4	RES, VAR, CERMET, 200+/-10%, 1/2W	285148	89536	285148	1		
R5	RES, VAR, CERMET, 50 +/-10%, 1/2W	285122	89536	285122	2		
R6	RES, VAR, CERMET, 20 +/-20%, 1/2W	261180	75378	190PC200B	1		
R7	RES, VAR, CERMET, 50 +/-10%, 1/2W	285122	89536	285122	REF		
R8	RES, VAR, CERMET, 50K +/-10%, 1/2W	288290	89536	288290	1		
R9	REF. AMP SET (U1,R9,R14,R15,R16)	415034	89536	415034	REF		
R10	RES, MTL. FILM, 3.4K +/-1%, 1/8W	260323	91637	MFF1-83401F	1		
R11	RES, MTL. FILM, 12.1 +/-1%, 1/8W	296608	91637	MFF1-812R1F	2		
R12	RES, MTL. FILM, 24.3 +/-1%, 1/8W	281816	91637	MFF1-824R3F	1		
R13	RES, MTL. FILM, 12.1 +/-1%, 1/8W	296608	91637	MFF1-812R1F	REF		
R14	REF. AMP SET (U1,R9,R14,R15,R16)	415034	89536	415034	REF		
R15	REF. AMP SET (U1,R9,R14,R15,R16)	415034	89536	415034	REF		
R16	REF. AMP SET (U1,R9,R14,R15,R16)	415034	89536	415034	REF		
R17	RES, MTL. FILM, 10K +/-1%, 1/8W	328120	91637	MFF1-81002F	2		
R18	RES, MTL. FILM, 10K +/-1%, 1/8W	328120	91637	MFF1-81002F	REF		
R19	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	3		
R20	RES, MTL. FILM, 10K +/-1%, 1/8W	168260	91637	MFF1-81002F	3		
R21	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R22	RES SET (R22, R23)	409896	89536	409896	1		
R23	RES SET (R22, R23)	409896	89536	409896	REF		
R24	RES, DEP. CAR, 470 +/-5%, 1/4W	343434	80031	CR251-4-5P470E	1		

Table 5-12. A10A1 A/D Analog PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
R25	RES, MTL. FILM, 42.2K +/-1%, 1/8W	221655	91637	MFF1-84222F	2		
R26	RES, MTL. FILM, 42.2K +/-1%, 1/8W	221655	91637	MFF1-84222F	REF		
R27	RES, DEP. CAR, 62 +/-5%, 1/4W	441634	80031	CR251-4-5P62E	1		
R28	RES, MTL. FILM, 10K +/-1%, 1/8W	168260	91637	MFF1-81002F	3		
R29	RES, DEP. CAR, 33K +/-5%, 1/4W	348888	80031	CR251-4-5P33K	2		
R30	RES, MTL. FILM, 10K +/-1%, 1/8W	168260	91637	MFF1-81002F	REF		
R31	RES, MTL. FILM, 11.3K +/-1%, 1/8W	293639	91637	MFF1-81132F	1		
R32	RES, MTL. FILM, 24.9K +/-1%, 1/8W	291369	91637	MFF1-82492F	1		
R33	RES, DEP. CAR, 47 +/-5%, 1/4W	441592	80031	CR251-4-5P47E	2		
R34	RES SET (R34,R35,R50-54,R56)	409946	89536	409946	1		
R35	RES SET (R34,R35,R50-54,R56)	409946	89536	409946	REF		
R36	RES, MTL. FILM, 26.7K +/-1%, 1/8W	245779	91637	MFF1-82672F	1		
R37	RES, DEP. CAR, 47 +/-5%, 1/4W	441592	80031	CR251-4-5P47E	REF		
R38	RES, MTL. FILM, 75K +/-1%, 1/8W	291443	91637	MFF1-87502F	3		
R39	RES, MTL. FILM, 75K +/-1%, 1/8W	291443	91637	MFF1-87502F	REF		
R40	RES, DEP. CAR, 15K +/-5%, 1/4W	348854	80031	CR251-4-5P15K	2		
R41	RES, MTL. FILM, 75K +/-1%, 1/8W	291443	91637	MFF1-87502F	REF		
R42	RES, DEP. CAR, 3K +/-5%, 1/4W	441527	80031	CR251-4-5P3K	1		
R43	RES, DEP. CAR, 510 +/-5%, 1/4W	441600	80031	CR251-4-5P510E	1		
R44	RES, DEP. CAR, 1.5K +/-5%, 1/4W	343418	80031	CR251-4-5P1K5	1		
R45	RES, DEP. CAR, 470K +/-5%, 1/4W	342634	80031	CR251-4-5P470K	1		
R46	RES, MTL. FILM, 665 +/-1%, 1/8W	320028	91637	MFF1-86650F	1		
R47	RES, MTL. FILM, 1M +/-1%, 1/8W	268797	91637	MFF1-81004F	1		
R48	RES, DEP. CAR, 15K +/-5%, 1/4W	348854	80031	CR251-4-5P15K	REF		
R49	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R50	RES SET (R34,R35,R50-54,R56)	409946	89536	409946	REF		
R51	RES SET (R34,R35,R50-54,R56)	409946	89536	409946	REF		
R52	RES SET (R34,R35,R50-54,R56)	409946	89536	409946	REF		
R53	RES SET (R34,R35,R50-54,R56)	409946	89536	409946	REF		
R54	RES SET (R34,R35,R50-54,R56)	409946	89536	409946	REF		
R55	RES, MTL. FILM, 56.2 +/-1%, 1/8W	305938	91637	MFF1-856R2F	1		
R56	RES SET (R34,R35,R50-54,R56)	409946	89536	409946	REF		
R58	RES, MTL. FILM, 2573 +/-0.1%, 1/8W	321463	91637	MFF1-82573F	1		
R60	RES, DEP. CAR, 33K +/-5%, 1/4W	348888	80031	CR251-4-5P33K	REF		
R61	RES, MTL. FILM, 57.6K +/-1%, 1/8W	289116	91637	MFF1-85762F	1		
R62	RES, MTL. FILM, 66.5K +/-1%, 1/8W	289082	91637	MFF1-86652F	1		
R63	RES, MTL. FILM, 100K +/-1%, 1/8W	248807	91637	MFF1-81003F	1		
R64	RES, VAR, CERMET, 10 +/-20%, 1/2W	344135	75378	190PC100B	REF		
R65	RES, DEP. CAR, 820 +/-5%, 1/4W	442327	80031	CR251-4-5P820E	1		
R66	RES, DEP. CAR, 5.1K +/-5%, 1/4W	368712	80031	CR251-4-5P5K1	1		
R67	RES, MTL. FILM, 18.7 +/-1%, 1/8W	441776	91637	MFF1-812R7F	1		
R68	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	1		
TP1-TP7	TERMINAL, TEST POINT	179283	89536	179283	7		
U1	REF. AMP SET (U1,R9,R14,R15,R16)	415034	89536	415034	1		
U2	IC, OP AMP	271502	12040	LM301A	2	1	
U3	IC, OP AMP	271502	12040	LM301A	REF		
U4	IC, OP-AMP, MONOLITHIC, J-FET INPUT	429837	12040	LF356F	2	1	
U5	IC, LIN, VOL, FOLLOWER	288365	12040	LM310H	2	1	
U6	IC, LIN, VOL, FOLLOWER	288365	12040	LM310H	REF		
U7	IC, OP-AMP, MONOLITHIC, J-FET INPUT	429837	12040	LF356F	REF		
U8	IC, OP AMP	225961	24355	AD3092	1	1	
U15	RES NETWORK, 33K	413146	89536	413146	1	1	
U19	RES NETWORK, 100K	380618	89536	380618	1	1	

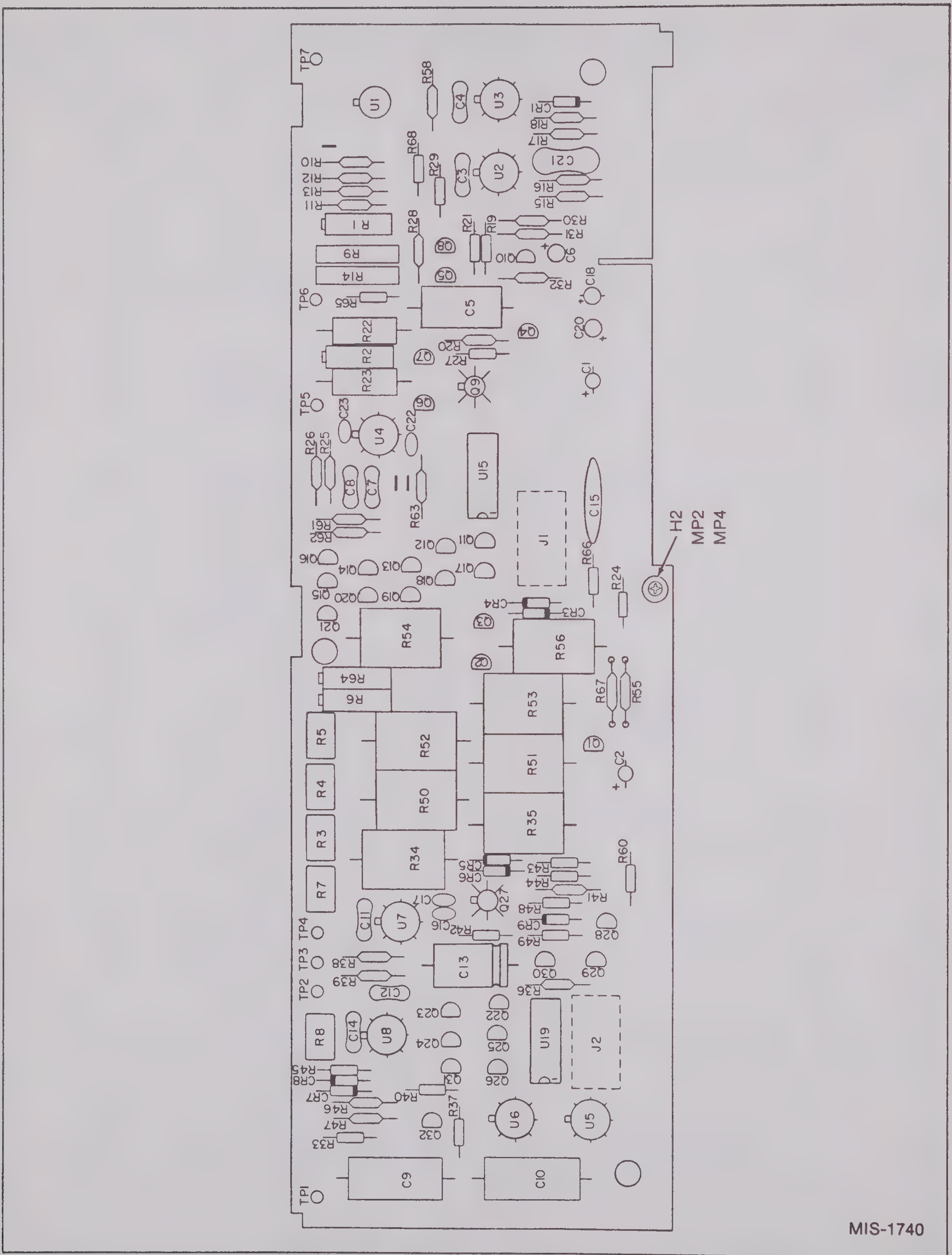
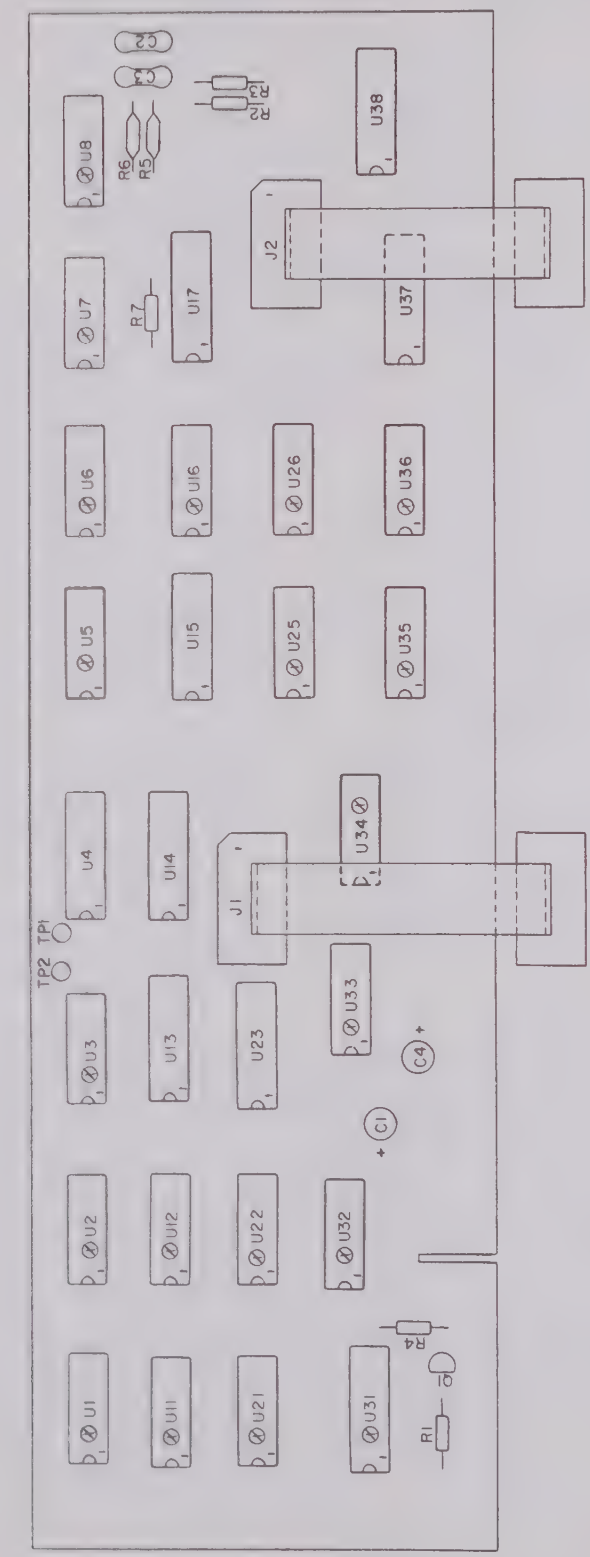

TP7
U1
R58
C4
U3
CR1
R18
R17
R68
R29
C3
U2
C21
R10
R12
R13
R11
R16
R15
R1
R28
R21
R19
R30
R31
R9
Q8
Q10
C6
R14
Q5
R32
C18
TP6
R65
C5
R22
C20
Q4
R2
R20
R27
Q7
R23
C1
Q9
TP5
C23
U4
C22
Q6
R26
R25
C8
C7
U15
C15
R63
J1
R61
R62
Q11
Q12
Q16
Q14
Q13
Q17
R66
H2
MP2
MP4
Q18
R24
Q15
Q20
Q19
CR4
CR3
Q21
R54
Q3
R56
Q2
R64
R6
R67
R55
R53
R5
R52
Q1
R51
C2
R4
R50
R3
R35
R34
CR5
CR6
R43
R44
R60
R7
Q27
R41
C17
R48
C11
U7
C16
CR9
TP4
R42
Q28
R49
TP3
R38
C13
Q30
Q29
R39
R36
TP2
C12
R8
C14
U8
Q23
Q22
U19
J2
Q24
Q25
R45
CR8
Q31
Q26
CR7
R40
R46
R37
U6
U5
R47
Q32
R33
TP1
C9
C10
MIS-1740

Figure 5-12. A10A1 A/D Analog PCB Assembly

Table 5-13. A10A2 Fast R^2 A/D Converter Digital PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
A10A2	⊗FAST R2 A/D CONV DGTL PCB ASSEMBLY FIGURE 5-13 (MIS-4141)	383760	89536	383760	REF		
C1	CAP, TA, 220 UF +/-20%, 6V	408682	56289	196D227X0006TE4	2		
C2	CAP, MICA, 82 PF +/-5%, 500V	148502	72136	DM15F820J	2		
C3	CAP, MICA, 82 PF +/-5%, 500V	148502	72136	DM15F820J	REF		
C4	CAP, TA, 220 UF +/-20%, 6V	408682	56289	196D227X0006TE4	REF		
J1	CABLE ASSY, 16 PIN CONN	380576	08261	5122-003.5	2		
J2	CABLE ASSY, 16 PIN CONN	380576	08261	5122-003.5	REF		
Q1	TRANSISTOR, SI, PNP	226290	04713	MPS3640	1		
R1	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K	1		
R2	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	2		
R3	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	REF		
R4	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	1		
R5	RES, MTL. FILM, 100K +/-1%, 1/8W	248807	91637	MFF1-81003F	2		
R6	RES, MTL. FILM, 100K +/-1%, 1/8W	248807	91637	MFF1-81003F	REF		
R7	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	1		
TP1, TP2	TERMINAL, TEST POINT	179283	89536	179283	2		
U1	⊗ IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE	9	2	
U2	⊗ IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE	REF		
U3	⊗ IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	3	1	
U4	RES NETWORK	380618	89536	380618	3	1	
U5	⊗ IC, C-MOS, DUAL, COMPLEMENTARY	408013	02735	CD4007AE	1	1	
U6	⊗ IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE	REF		
U7	⊗ IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	REF		
U8	⊗ IC, C-MOS, QUAD, 2-INPUT NAND GATES	355198	02735	CD4011AE	2	1	
U11	⊗ IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE	REF		
U12	⊗ IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE	REF		
U13	RES NETWORK	380618	89536	380618	REF		
U14	IC, LINEAR, 5 XSTR ARRAY	380188	02735	CA3183E	3	1	
U15	IC, LINEAR, 5 XSTR ARRAY	380188	02735	CA3183E	REF		
U16	⊗ IC, C-MOS, QUAD, 2-INPUT OR GATE	408393	02735	CD4071BE	2	1	
U17	IC, LINEAR, 5 XSTR ARRAY	380188	02735	CA3183E	REF		
U21	IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	REF		
U22	IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE	REF		
U23	IC, LINEAR, 5 XSTR ARRAY	477778	89536	477778	2	1	
U25	⊗ IC, C-MOS, QUAD, 2-INPUT AND GATE	408401	02735	CD4081BE	1	1	
U26	⊗ IC, DGTL, C-MOS, QUAD, 2-INPUT OR GATE	408393	02735	CD4071BE	REF		
U31	⊗ IC, C-MOS, DIV BY -8, COUNTER/DIV	403360	02735	CD4022AE	1	1	
U32	⊗ IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE	REF		
U33	⊗ IC, C-MOS, QUAD, 2-INPUT NAND GATES	375147	02735	CD4023AE	1	1	
U34	⊗ IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE	REF		
U35	⊗ IC, C-MOS, DUAL TYPE D FLIP FLOP	340117	02735	CD4013AE	REF		
U36	⊗ IC, C-MOS, QUAD, 2-INPUT NAND GATES	355198	02735	CD4011AE	REF		
U37	RES NETWORK	380618	89536	380618	REF		
U38	IC, LINEAR, 5 XSTR ARRAY	477778	89536	477778	REF		


C2
C3
R3
R2
R6
R5
U8
U38
J2
U37
U7
R7
U17
U6
U16
U26
U36
U5
U15
U25
U35
U4
U14
U34
J1
TP1
TP2
U33
U3
U13
U23
C4
C1
U2
U12
U22
U32
R4
U1
U11
U21
U31
R1

CAUTION
SUBJECT TO DAMAGE BY
STATIC ELECTRICITY

MIS-1741

Figure 5-13. A10A2 Fast R² A/D Converter Digital PCB Assembly

Section 6
Option & Accessory Information

TABLE OF CONTENTS

OPTION/ MODEL NO.	DESCRIPTION	PAGE

ACCESSORIES

M04-205-600	Rack Ear Mounting Assembly	600-1
80K-6	High Voltage Probe	600-1
80K-40	High Voltage Probe	600-1
83RF	High Frequency Probe	600-1
85RF	High Frequency Probe	600-1

OPTIONS

-01	AC/DC Converter (Averaging)	601-1
-02A	Ohms Converter	602A-1
-03	Current Shunts	603-1
-05	IEEE Standard 488-1975 Interface	605-1
-06	Bit Serial Asynchronous Interface	606-1
-07	Parallel Interface	607-1
-08A	Isolator (Standard)	608A-1
-09A	AC/DC Converter (RMS)	609A-1

6-1. INTRODUCTION

6-2. This section of the manual contains information concerning options and accessories available for use with the multimeter. Subsections are included for accessories and for each option. The Table of Contents identifies each item by name, number, and appropriate page number.

6-3. ACCESSORIES

6-4. Several accessories are documented in the first subsection. Additional accessories are listed in Section 1 of this manual. Complete documentation is provided for any accessory ordered for the multimeter.

6-5. OPTIONS

6-6. Documentation for all currently available options is also included in this section. A subsection is devoted to each option. Applicable pages are identified by section, option number, and page number within the subsection. For example, page 3 for the -02A option is identified as 602A-3.

6-7. Programming instructions for any of the remote interface options (-05, -06, or -07) are included in Section 2A of this manual. The Isolator, which is a standard module with the 8505A and 8506A, is documented in subsection 608A.

6-8. Each subsection includes all information to install, operate, and maintain the option. Specifications, a list of replaceable parts, and a schematic diagram are also provided.

Accessories

600-1. RACK EAR MOUNTING ASSEMBLY

600-2. Figure 600-1 illustrates installation of the Rack Ear Mounting Assembly. Use the following procedure:

1. Remove the nameplate decals from the handles.
2. Remove the screws from the handles.
3. Attach the rack ears with #8-32 x 5/8 PHP screws (included with the kit).
4. Note the hole pattern in the top and bottom trim items. Remove the corresponding screws from the multimeter's top and bottom covers.
5. Attach the top and bottom trim items with #6-32 x 3/8 PHP screws and lock washers (included with the kit).

600-3. HIGH VOLTAGE PROBE (80K-6)

600-4. The 80K-6 extends the voltage measuring capability of an ac/dc voltmeter up to 6000 volts. A 1000:1 voltage divider provides a high input impedance. High accuracy is provided when the divider is used with a voltmeter having a 10 Mohm input impedance. A molded plastic body houses the divider and protects the user from the voltage being measured.

600-5. HIGH VOLTAGE PROBE (80K-40)

600-6. The 80K-40 is a high voltage accessory probe designed to extend the voltage measuring capability of an ac/dc voltmeter up to 40,000 volts. The probe is a precision 1000:1 voltage divider formed by two matched metal-film resistors. The unusually high input impedance offered by these resistors minimizes circuit loading and optimizes measurement accuracy. A special plastic body houses the divider and provides the user with isolation from the voltage being measured.

600-7. HIGH FREQUENCY PROBE (83RF)

600-8. The 83RF converts a dc voltmeter into a high frequency, 100 kHz to 100 MHz ac voltmeter. Conversion from ac to dc is on a one-to-one basis over a range of 0.25 to 30V rms. The probe's dc output is calibrated to be equivalent to the rms value of a sinewave input.

600-9. HIGH FREQUENCY PROBE (85RF)

600-10. The 85RF is designed to convert a dc voltmeter into a high frequency, 100 kHz to 500 MHz ac voltmeter. Ac to dc conversion ratio is one-to-one over a range of 0.25 to 30V rms. The probe's dc output is calibrated to be equivalent to the rms value of a sinewave output.

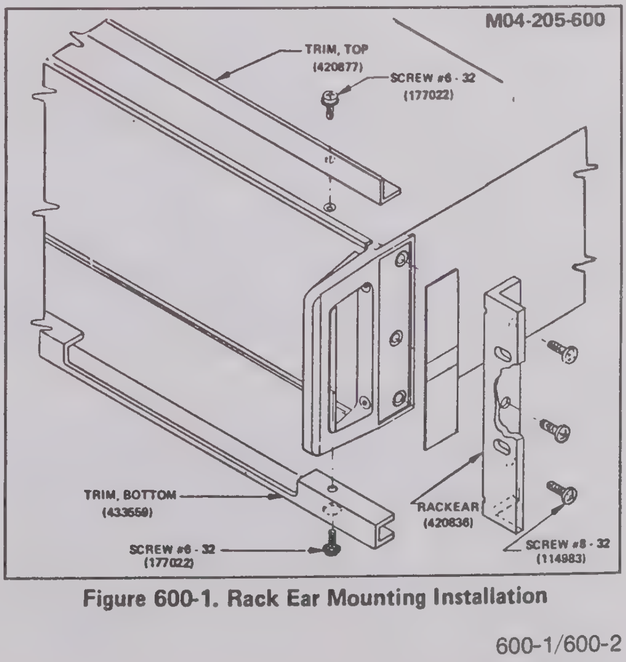


Figure 600-1. Rack Ear Mounting Installation

Option —01
AC/DC Converter (Averaging)

601-1. INTRODUCTION

601-2. The Average Responding AC Converter is used to convert ac signals to dc levels which can be measured by the A/D Converter. A maximum input of 1000V rms (or 2 x 10^7 Volt-hertz product, whichever is less) may be applied with resolutions available to one microvolt. Input impedance is 1 MΩ with less than 100 pf shunt capacity.

601-3. SPECIFICATIONS

601-4. Table 601-1 lists the specifications for the –01 option.

601-5. INSTALLATION

601-6. Refer to Section 4 of this manual under Module Installation and Removal for instructions on installing modules. The interconnect diagram in Section 8 contains a table listing the permissible and preferred slots for each module.

601-7. OPERATING NOTES

601-8. The operating instructions given in Section 2 of this manual apply for operation of the instrument with the AC/DC Converter (Averaging) installed. The lowest range available through the average responding ac converter is the 1V range.

601-9. For rated accuracy below 400 Hz, the slow filter (FILTER LED on) must be selected. This selects additional filtering in the ac converter as well as in the Active Filter module. External reference measurements may be made as described in Section 2 but the external reference inputs must be dc only.

601-10. Once the instrument is zeroed for DC Volts, no additional zeroing is required for AC Volts measurements. Using the Offset function as an AC Volts zero could result in greater error due to the nature of the floor digits specifications.

601-11. THEORY OF OPERATION

601-12. The AC/DC Converter accepts signals either from the input terminals or from the optional current shunts module (RT1 and RT3). Refer to Figure 601-1. Input signals are applied to the input range amplifier, U1, through a dc blocking capacitor, C1, and a 2 MΩ resistor, R2. R2 establishes the input resistance of the amplifier. U1 is a voltage amplifier controlling a current source, Q4 and Q6. Q4 and Q6 change the low impedance of U1 to a high impedance for driving CR10 and CR11. The high impedance at the collectors of Q4 and Q6 minimizes error introduced by the nonlinearity of CR10 and CR11, which have a relatively low impedance.

601-13. Distortion of the waveform occurs at the collectors of Q4 and Q6 due to the nonconducting regions of CR10 and CR11. During the portion of the waveform in which CR10 and CR11 are not conducting, the feedback path of the amplifier is effectively broken and the gain of the amplifier becomes very high. The time required for the waveform to cross the nonconducting region is determined by the slew rate of the amplifier. When CR10 and CR11 are conducting, the gain of the amplifier is controlled by R18 and associated parallel resistors as selected by K3, K4, and K5.

601-14. U6 is configured as a differential amplifier having a gain of approximately 8 times the average-to-rms scaling factor of 1.11. Signals from CR10 and CR11 are applied to U6 through a matched temperature coefficient resistor set which provides the gain setting for U6, and filtering with capacitors C18, C19, C21, and C22. When the slow filter is selected, additional filtering, C17 and C20, is switched in by Q12 and Q13.

Table 601-1. AC/DC Converter (Averaging) Specifications

Input Characteristics

RANGE	FULL SCALE 5½ DIGITS	RESOLUTION		INPUT IMPEDANCE
		6½ DIGITS*	5½ DIGITS	
1V 10V 100V 1000V	2.50000V 20.0000V 160.000V 1000.00V	1 µV 10 µV 100 µV 1 mV	10 µV 100 µV 1 mV 10 mV	1 MΩ shunted by <100 pf

*In AVG operating mode (8505A/8506A).

Accuracy ±(% of Reading + Number of Counts)[1]

FREQUENCY*	24-HOUR 23°C ±1°C		90-DAY 23°C ±5°C	
	0 to 500V	>500V	0V to 500V	>500V
30 Hz - 50 Hz	0.3 + 5	0.4 + 5	0.5 + 5	0.55 + 5
50 Hz - 10 kHz	0.035 + 5	0.075 + 5	0.05 + 5	0.1 + 5
10 kHz - 40 kHz	—	0.1 + 5	—	0.15 + 5
10 kHz - 50 kHz[2]	0.075 + 5	—	0.1 + 5	—
50 kHz - 100 kHz[3]	0.3 + 5	—	0.5 + 5	—

*Slow filter must be used for full accuracy below 400 Hz.

>90 DAY: 23°C ±5°C
ADD TO THE 90 DAY SPECIFICATION PER MONTH THE FOLLOWING % OF READING

FREQUENCY	0 TO 500V	>500V
30 Hz - 50 Hz	0.056	0.05
50 Hz - 10 kHz	0.0056	0.011
10 kHz - 40 kHz	—	0.017
10 kHz - 50 kHz	0.011	—
50 kHz - 100 kHz	0.056	—

Operating Characteristics

TEMPERATURE COEFFICIENT ±(% of Reading + Number of Counts /°C[1]

FREQUENCY	0°C TO 18°C AND 28°C TO 50°C
30 Hz to 50 kHz	0.003 + 0.5
50 kHz to 100 kHz	0.01 + 1.0

COMMON MODE REJECTION .... >120 dB, dc to 60 Hz, with 100Ω in series with either lead.

RESPONSE TIME

Analog Settling Time .... 100 ms with Fast Filter and 500 ms with Slow Filter, to within 0.05% of in-range step change.

Digitizing Time .... Same as dc volts (see Section 1)

MAXIMUM INPUT VOLTAGE .... 1000V rms, 1400V peak, or 2 x 10^7 volts-hertz whichever is less.

NOTES:

[1] With inputs between 0.1% of range and full scale, 5½ digit display. For 6½ digit display, multiply Number of Counts by 10.

[2] On 1V range add 7 counts.

[3] On 1V range add 35 counts.

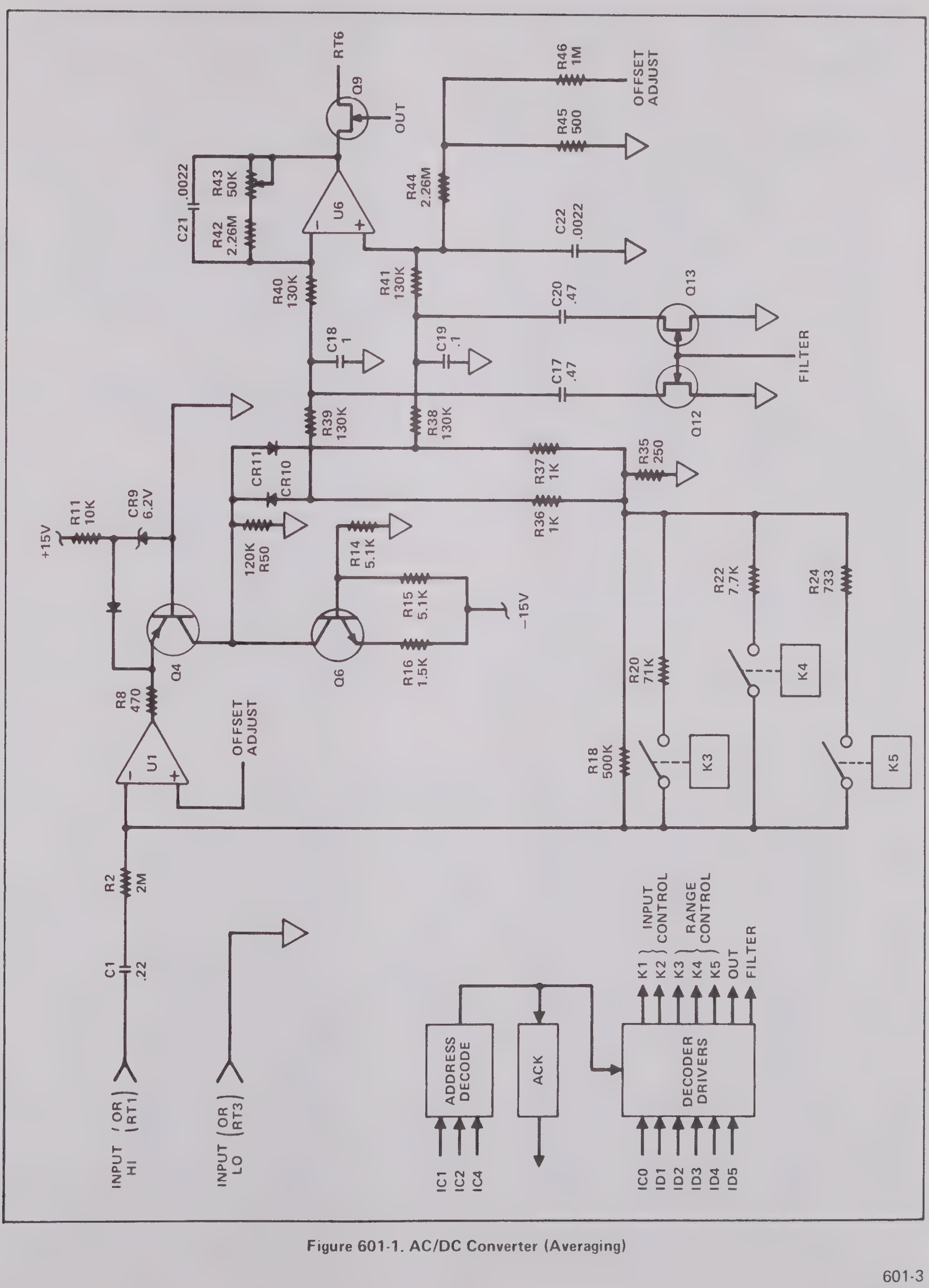

RT6
Q9
OUT
R46 1M
OFFSET ADJUST
R45 500
R44 2.26M
C22 .0022
C21 .0022
R43 50K
R42 2.26M
U6
R40 130K
R41 130K
C20 .47
Q13
FILTER
C18 1
C19 .1
C17 .47
Q12
R39 130K
R38 130K
CR11
CR10
R37 1K
R35 250
R36 1K
R11 10K
CR9 6.2V
+15V
120K R50
R14 5.1K
R15 5.1K
-15V
R16 1.5K
Q4
Q6
R8 470
U1
OFFSET ADJUST
R20 71K
R22 7.7K
R24 733
K3
K4
K5
R18 500K
R2 2M
C1 .22
INPUT HI (OR RT1)
INPUT LO (OR RT3)
ADDRESS DECODE
ACK
DECODER DRIVERS
IC1
IC2
IC4
IC0
ID1
ID2
ID3
ID4
ID5
K1
K2
K3
K4
K5
OUT
FILTER
INPUT CONTROL
RANGE CONTROL

Figure 601-1. AC/DC Converter (Averaging)

601-15. MAINTENANCE

601-16. Performance Test

601-17. Sequentially apply the inputs listed in Table 601-2, ensuring that the reading is between the limits specified.

Table 601-2. Performance Test

Input Freq	Voltage	8500 Reading	
		Low	High
10 kHz	1 V	0.99945	1.00055
50 kHz	1 V	0.99895	1.00105
10 kHz	10 V	9.9945	10.0055
50 kHz	10 V	9.9895	10.0105
10 kHz	100 V	99.945	100.055
50 kHz	100 V	99.895	100.105
10 kHz	1000 V	998.95	1001.05

601-18. Calibration

601-19. Use the DC portion of the instrument to adjust the AC balance of the AC/DC Converter using the following procedure.

1. Select DC Volts, 100 mV range, and slow filtering (FILTER indicator illuminated).
2. Connect TP1 on the AC/DC Converter to the Input HI terminal.
3. Adjust R17 (AC Balance) for a reading of 0 ± 20 μV.
4. Remove the connection between TP1 and Input HI.

601-20. Select AC Volts and manually select the 1000V range. Connect the AC Calibrator to the instrument. Sequentially apply the inputs listed in Table 601-3, making adjustments as required to the nominal value. Repeat steps 1 through 6 until all six steps are within the stated tolerance without amking any adjustments. Those inputs for which no adjustment is listed are to verify that the averaging Converter is within tolerance.

601-21. The adjustment in step 13 is performed using a computation derived from the readings in steps 13 and 14 if either step is out of tolerance. Use the following procedure to compute the value of the adjustment:

1. Subtract and record the absolute value of the reading in step 13 from the absolute value of the nominal reading, e.g. if the reading was 18.9322 you would subtract 189322 from 190000 for a result of +678.
2. Subtract and record the absolute value of the reading in step 14 from the absolute value of the nominal reading, e.g. if the reading was 1.90503 you would subtract 190503 from 190000 for a result of -503.

Table 601-3. Calibration Chart

Step	Input			Reading			Adjust
	Range	Voltage	Frequency	Minimum	Nominal	Maximum	
1	1000V	500	500 Hz	499.93	500.00	500.07	R43
2	1000V	500	60 kHz	499.92	500.00	500.08	C23
3	1000V	1	500 Hz	0.99	1.00	1.01	R47
4	1000V	1	100 kHz	0.97	0.98	0.98	C16
5	1V	1	500 Hz	0.99993	1.00000	1.00007	R19
6	1V	1	60 kHz	0.99975	1.00000	0.99990	C8
7	10V	10	500 Hz	9.9993	10.0000	10.0007	R21
8	10V	10	60 kHz	9.9991	10.0000	10.0009	C10
9	100V	100	500 Hz	99.993	100.000	100.007	R23
10	100V	100	60 kHz	99.991	100.000	100.009	C25
11	100V	100	10 kHz	99.975	100.000	100.025	
12	10V	19	30 Hz	18.9615	19.0000	19.0385	
13	10V	19	100 kHz	18.9520	19.0000	19.0480	
14	1V	1.9	100 kHz	1.89520	1.90000	1.90480	(R55)
15	1V	1.9	10 kHz	1.89520	1.90000	1.90050	
16	1V	.1	500 Hz	0.09995	0.10000	0.10005	
17	1000V	1000	20 kHz	999.50	1000.00	1000.50	
18	1V	5 0.025	50 kHz	0.02492	0.02500	0.2508	
19	1V	0.025	100 kHz	0.02465	0.02500	0.02535	

3. Algebraically add the two recorded results and double the result. With the example readings inserted the result is: 2*[+678+(-503)] = +350.
4. With R55 adjust the reading in step 13. If the number is positive (+) increment the reading the computed number of digits, if it is negative (-) decrement the reading the computed number of digits.
5. Repeat the process until both readings are within the stated tolerances.

601-22. Troubleshooting

601-23. Table 601-4 contains a procedure to ensure the problem actually is in the AC Converter. Figure 601-2 contains symptom analysis of the AC Converter and address and data information.

601-24. PARTS LIST

601-25. Table 601-5 contains a parts breakdown for the AC/DC Converter (Averaging). Refer to Section 5 of this manual for ordering and use code information.

CAUTION

Indicated devices are subject to damage by static discharge.

Table 601-4. AC Converter Isolation

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Do the DC Performance Test (Section 4).		
2	Is DC Volts within tolerance?	3	Section 4
3	Is the Calibration Memory module installed?	4	6
4	Remove the Calibration Memory module. Is AC OK?	5	6
5	Bad Calibration Memory. Go to Section 604.		
6	Is Isolator installed?	7	10
7	Replace Isolator with Bus Interconnect/Monitor pcb.		
8	Is AC OK?	9	10
9	Bad Isolator. Go to Section 608.		
10	Remove DC Signal Conditioner. Is AC OK?	11	12
11	DC Signal Conditioner interfering with AC. The problem in the DC Signal Conditioner is one of the following: 1. Digital Logic Bad, 2. K1 or K2 shorted, 3. Q6, Q7, Q8 Bad.		
12	Install Bus Interconnect/Monitor if not already installed.		
13	Check power supply voltages as follows: VA1 = +14.25 to 15.75V VA2 = –14.25 to –15.75V VA3 = +29 to 32V VA4 = –29 to –32V Vcc = –15V, Vss = –20V } Difference = 4.9 to 5.2		
14	Are the supply voltages OK?	15	Section 4
15	Go to Figure 601-2.		

SYMPTOM	POSSIBLE FAILURE
Noisy Reading	U1, U6
Single range bad	Digital logic, range relay
All ranges bad	U1, U6
Reading out of tolerance	Range relay, U1
Overrange	U6
High frequency bad	U6
No Output	Q9, Q10, Q11, U6, U1, K1, K2
Interfering with DC or Ohms reading	K1 shorted, Q9 leaky

Address: IC 4, 2, 1 high

Data: ID0 = 1, ID1 = 0	AC Voltage Input Terminals
ID0 = 0, ID1 = 1	AC Current, RT1 and RT3
ID2 = 0	Filter on
ID3 = 0	10V range
ID4 = 0	100V range
ID5 = 0	1000V range
ID5, 4, 3 = 1	1V range

If U1, Q4, Q6, R51, R52, CR10, or CR11 are replaced it may be necessary to change the value of R51 or R52 to correct offset error. Use the following procedure.

1. Remove R51 or R52, whichever is installed.
2. Connect test DMM Hi to TP1, Lo to TP2.
3. With R17 fully CW, the reading should be more than +100 μV.
4. If not, center R17 and select a resistor value from the following table which has the closest corresponding offset voltage. For negative readings, install the resistor as R52. For positive readings, install the resistor as R51.

OFFSET	RESISTOR	J.F. PART #
.25 mV	2.7 MΩ	193490
.5	1.5M	182857
.75	910K	285338
1.0	680K	188433
1.25	560K	220533
1.5	470K	188441
1.75	390K	193383
2.0	360K	234690
2.25	300K	234682
2.5	270K	220061
2.75	240K	218016
3.0–3.25	220K	160937
3.5	200K	248781

Figure 601-2. Symptom Analysis

Table 601-5. AC/DC (Avg) PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
-01	AC/DC CONVERTER (AVG) PC ASSEMBLY FIGURE 601-3 (MIS-4101T)	ORDER	BY	OPTION -01			
C1	CAP, FILM, 0.22 UF +/-20%, 1200V	268904	89536	268904	1		
C2	CAP, MICA, 47 PF +/-5%, 500V	148536	72136	CM15E470J	1		
C5	CAP, MICA, 33 PF +/-5%, 500V	160317	72136	DM15E330J	1		
C6	CAP, TA, 4.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	8		
C7	CAP, CER, 1 PF +/-0.25%, 100V	436477	80031	2222-638-03108	1		
C8	CAP, VAR, 0.25-1.5 PF, 2000V	273151	74970	273-0001-002	2		
C9	CAP, MICA, 15 PF +/-2%, 500V	335612	72136	DM15C150G	2		
C10	CAP, VAR, 0.8-10 PF, 200V	229930	91293	JMC5201	1		
C11	CAP, MICA, 150 PF +/-1%, 500V	226134	72136	DM15F151F	1		
C12	CAP, MICA, 15 PF +/-2%, 500V	335612	72136	DM15C150G	REF		
C13	CAP, MICA, 1800 PF +/-2%, 500V	447441	72136	DM19F182G	1		
C14	CAP, TA, 4.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	REF		
C15	CAP, TA, 4.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	REF		
C16	CAP, VAR, CERMET, 1.7-10 PF, 250V	375238	52769	GKC10000	2		
C17	CAP, POLYESTER, 0.47 UF +/-10%, 100V	369124	89536	369124	2		
C18	CAP, POLYESTER, 0.10 UF +/-10%, 100V	393439	89536	393439	2		
C19	CAP, POLYESTER, 0.10 UF +/-10%, 100V	393439	89536	393439	REF		
C20	CAP, POLYESTER, 0.47 UF +/-10%, 100V	369124	89536	369124	REF		
C21	CAP, FILM, 0.0022 UF +/-10%, 50V	313239	06001	75F1R5A322	2		
C22	CAP, FILM, 0.0022 UF +/-10%, 50V	313239	06001	75F1R5A322	REF		
C23	CAP, VAR, 0.25-1.5 PF, 2000V	273151	74970	273-0001-002	REF		
C24	CAP, MICA, 68 PF +/-5%, 500V	148510	72136	DM15F680J	1		
C25	CAP, VAR, CERMET, 1.7-10 PF, 250V	375238	52769	GKC10000	REF		
C26	CAP, TA, 4.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	REF		
C27	CAP, TA, 4.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	REF		
C28	CAP, TA, 4.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	REF		
C29	CAP, TA, 4.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	REF		
C30	CAP, TA, 4.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	REF		
C31	CAP, TA, 22 UF +/-20%, 15V	423012	56289	196D226X0015KA1	2		
C32	CAP, TA, 22 UF +/-20%, 15V	423012	56289	196D226X0015KA1	REF		
C33	CAP, MICA, 10 PF +/-2%, 500V	335638	72136	DM15C100G	1		
CR1	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	6	2	
CR2	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR3	DIODE, SI, LO-CAP, LO-LEAK	348177	07263	FD7223	4	1	
CR4	DIODE, SI, LO-CAP, LO-LEAK	348177	07263	FD7223	REF		
CR5	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR6	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR7	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR8	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR9	DIODE, ZENER, UNCOMPENSATED	325811	07910	1N753A	2	1	
CR10	DIODE, SI, LO-CAP, LO-LEAK	348177	07263	FD7223	REF		
CR11	DIODE, SI, LO-CAP, LO-LEAK	348177	07263	FD7223	REF		
CR12	DIODE, ZENER, UNCOMPENSATED	325811	07910	1N753A	REF		
H1	SCREW, PHP, 4-40 X 3/16	129882	89536	129882	3		
H2	SCREW, RH FILISTER, 6-32 X 1/2 (not shown)	115006	89536	115006	3		
H3	SCREW, RHP, 4-40 X 3/8	256164	89536	256164	1		

Table 601-5. AC/DC (Avg) PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
K1	RELAY ASSY						
	RELAY, COIL, 6V	272070	71707	UD-6P	2		
	FOIL	313833	89536	313833	2		
	SWITCH, DRY REED	284091	95348	MR138	2		
	SWITCH, DRY REED	414300	95348	MR5830-7	2		
K2	RELAY ASSY				REF		
	RELAY, COIL, 6V	272070	71707	UD-6P	REF		
	FOIL	313833	89536	313833	REF		
	SWITCH, DRY REED	284091	95348	MR138	REF		
	SWITCH, DRY REED	414300	95348	MR5830-7	REF		
K3	RELAY, DRY REED	357566	71707	UF40069	3		
K4	RELAY, DRY REED	357566	71707	UF40069	REF		
K5	RELAY, DRY REED	357566	71707	UF40069	REF		
MP1	MODULE CASE ASSY., (INCLUDES MP2-MP9)	459016	89536	459016	1		1
MP2	CASE HALF, MODULE	402990	89536	402990	2		
MP3	CASE HALF, MODULE	402990	89536	402990	REF		
MP4	COVER, MODULE CASE	402974	89536	402974	1		
MP5	SHIELD, COVER	411926	89536	411926	1		
MP6	DECAL, AC/DC CONVERTER (AVERAGING)	413385	89536	413385	1		
MP7	DECAL, CAUTION	454504	89536	454504	1		
MP8	REAR GUARD	383364	89536	383364	1		
MP9	GUARD, FRONT	383356	89536	383356	1		
MP10	INSULATOR, AVG SHIELD (not shown)	437913	89536	437913	1		
MP11	SHIELD, AVG CONVERTER (not shown)	437905	89536	437905	1		
MP12	SHIELD, AVG CONVERTER, REAR (not shown)	437897	89536	437897	1		
MP13	SPRING, COIL (not shown)	424465	83553	C0120-014-0380	1		
MP14	SOCKET, COMPONENT LEAD	343285	00779	2-331272-6	8		
MP15	SPACER, STANOFF, 4-40	335604	89536	335604	1		
MP16	SPACER, STANDOFF, ROUND, 6-32	423806	89536	423806	3		
MP18	TERMINAL, FEED-THRU SLOT UNINSULATED	512012	88245	1308	2		
Q2	XSTR, SI, NPN	218396	04713	2N3904	4	1	
Q3	XSTR, SI, PNP	226290	04713	MPS3640	1	1	
Q4	XSTR, SI, PNP	195974	04713	2N3906	2	1	
Q5	XSTR, SI, NPN	218081	89536	218081	2	1	
Q6	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q7	XSTR, SI, NPN	218081	89536	218081	REF		
Q8	XSTR, FET, N-CHANNEL	352112	89536	352112	1	1	
Q9	XSTR, FET, N-CHANNEL	393314	89536	393314	1	1	
Q10	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q11	XSTR, SI, PNP	195974	04713	2N3906	REF		
Q12	XSTR, FET, N-CHANNEL	343830	89536	343830	2	1	
Q13	XSTR, FET, N-CHANNEL	343830	89536	343830	REF		
Q14	XSTR, SI, NPN	218396	04713	2N3904	REF		
R2	RES, MTL. FILM, 2M +/-0.5%, 1W	354894	89536	354894	1		
R3	RES, DEP. CAR, 120K +/-5%, 1/4W	441386	80031	CR251-4-5P120K	2		
R8	RES, DEP. CAR, 470 +/-5%, 1/4W	343434	80031	CR251-4-5P470E	1		

Table 601-5. AC/DC (Avg) PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
R9	RES, MTL. FILM, 49.9 +/-1%, 1/8W	305896	91637	CMF5549R9F	1		
R10	RES, MTL. FILM, 1M +/-1%, 1/8W	268797	91637	CMF551004F	1		
R11	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	3		
R12	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R13	RES, DEP. CAR, 75K +/-5%, 1/4W	394130	80031	CR251-4-5P75K	1		
R14	RES, DEP. CAR, 5.1K +/-5%, 1/4W	368712	80031	CR251-4-5P5K1	2		
R15	RES, DEP. CAR, 5.1K +/-5%, 1/4W	368712	80031	CR251-4-5P5K1	REF		
R16	RES, DEP. CAR, 1.5K +/-5%, 1/4W	343418	80031	CR251-4-5P1K5	1		
R17	RES, VAR, CERMET, 100K +/-10%, 1/2W	288308	89536	288308	3		
R18	RES, MTL. FILM, 500.85K +/-0.1%, 1/8W	424614	89536	424614	1		
R19	RES, VAR, CERMET, 5K +/-10%, 1/2W	288282	89536	288282	1		
R20	RES, MTL. FILM, 71.320K +/-0.1%, 1/8W	424515	89536	424515	1		
R21	RES, VAR, CERMET, 500 +/-10%, 1/2W	291120	89536	291120	1		
R22	RES, MTL. FILM, 7.704K +/-0.1%, 1/8W	436121	89536	436121	1		
R23	RES, VAR, CERMET, 50 +/-10%, 1/2W	285122	89536	285122	1		
R24	RES, MTL. FILM, 733.9 +/-0.1%, 1/8W	460212	89536	460212	1		
R25	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R26	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K	3		
R27	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	1		
R28	RES, DEP. CAR, 22K +/-5%, 1/4W	348870	80031	CR251-4-5P22K	1		
R29	RES, DEP. CAR, 15K +/-5%, 1/4W	348854	80031	CR251-4-5P15K	1		
R30	RES, DEP. CAR, 8.2K +/-5%, 1/4W	441675	80031	CR251-4-5P8K2	1		
R31	RES, DEP. CAR, 51K +/-5%, 1/4W	376434	80031	CR251-4-5P51K	3		
R32	RES, DEP. CAR, 51K +/-5%, 1/4W	376434	80031	CR251-4-5P51K	REF		
R33	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K	REF		
R34	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K	REF		
R35-R42	RESISTOR SET	441873	89536	441873	1		2
R43	RES, VAR, CERMET, 50K +/-10%, 1/2W	288290	89536	288290	1		
R44-R46	RESISTOR SET, PART OF R35-R42						2
R47	RES, VAR, CERMET, 100K +/-10%, 1/2W	288308	89536	288308	REF		
R48	RES, DEP. CAR, 51K +/-5%, 1/4W	376434	80031	CR251-4-5P51K	REF		
R49	RES, DEP. CAR, 330 +/-5%, 1/4W	368720	80031	CR251-4-5P330E	1		
R50	RES, DEP. CAR, 120K +/-5%, 1/4W	441386	80031	CR251-4-5P120K	REF		
R51	RESISTOR, SELECTED AT TEST FUNCTION.				1		3
R52	RESISTOR, SELECTED AT TEST FUNCTION.				REF		3
R53	RES, DEP. CAR, 100 +/-5%, 1/4W	348771	80031	CR251-4-5P100E	2		
R54	RES, DEP. CAR, 100 +/-5%, 1/4W	348771	80031	CR251-4-5P100E	REF		
R55	RES, VAR, CERMET, 100K +/-10%, 1/2W	288308	89536	288308	REF		
TP1	TERMINAL, TEST POINT	179283	89536	179283	1		
U1	IC, LIN, OP AMP	429951	12040	LF357AH	1	1	
U2	⊘ IC, C-MOS, HEX "D" FLIP FLOP	404509	12040	MM74C174N	1	1	
U3	⊘ IC, C-MOS, QUAD, 2-INPUT NAND GATES	375147	02735	CD4023AE	1	1	
U4	⊘ IC, C-MOS, HEX, INVERTER/BUFFER	381848	02735	CD4049AE	1	1	
U5	⊘ IC, TTL, HEX, INVERTER, BUFFER/DRIVER	288605	01295	SN7416N	1	1	
U6	⊘ IC, LIN, OP AMP	288928	12040	LM308AH	1	1	

1 USE P/N 459016 TO ORDER COMPLETE MODULE CASE, WITHOUT PCB ASSY.

2 R35 THRU R42 AND R44 THRU R46 ARE MATCHED RESISTORS. IF ANY ONE RESISTOR OF THIS SET NEEDS REPLACEMENT, THE WHOLE SET MUST BE INCLUDED IN THE REPLACEMENT.

3 RESISTORS ARE TEMPERATURE COMPENSATED AND MUST BE RETURNED FOR RESELECTION IF ANY REQUIRE REPLACEMENT. (R51 AND R52)

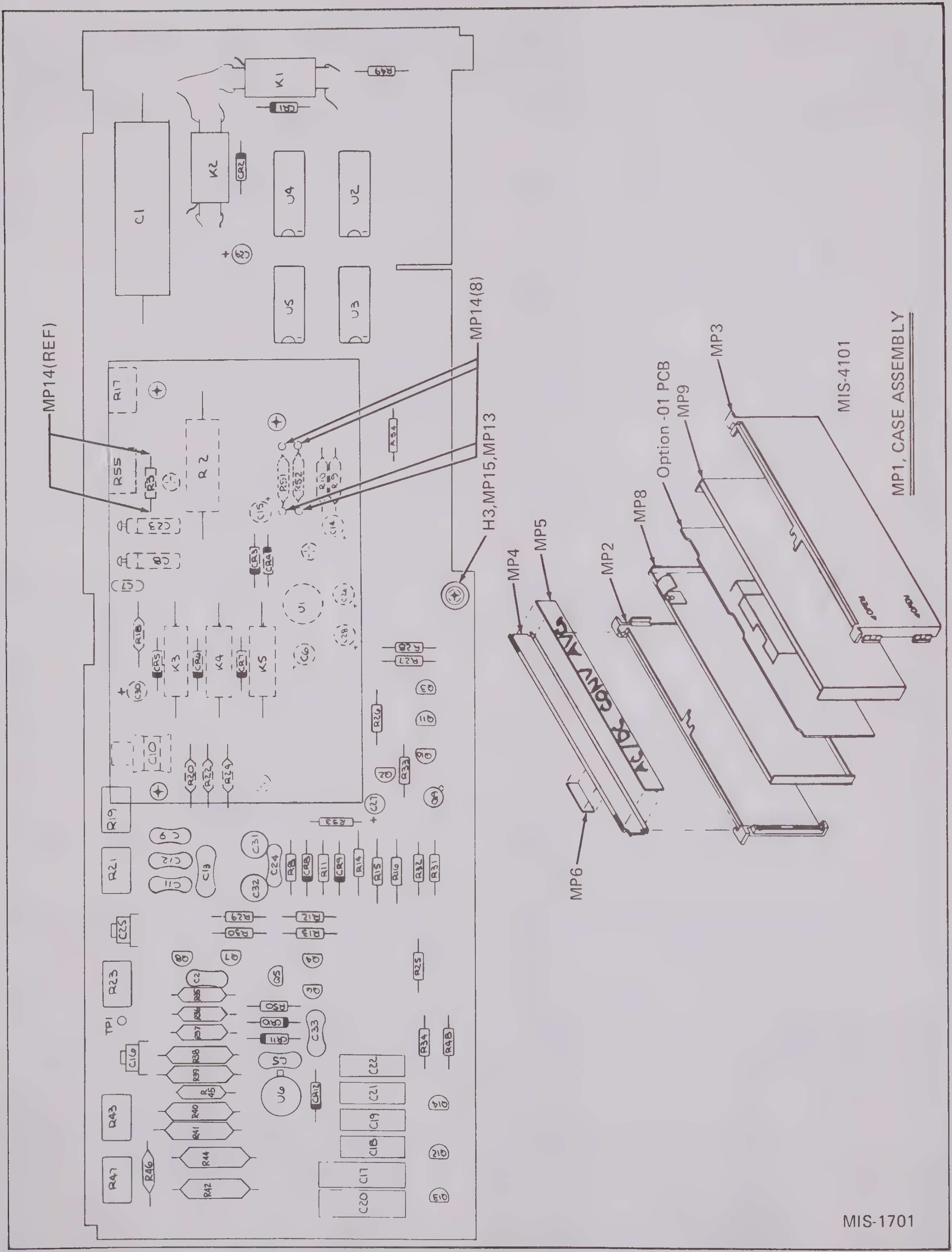
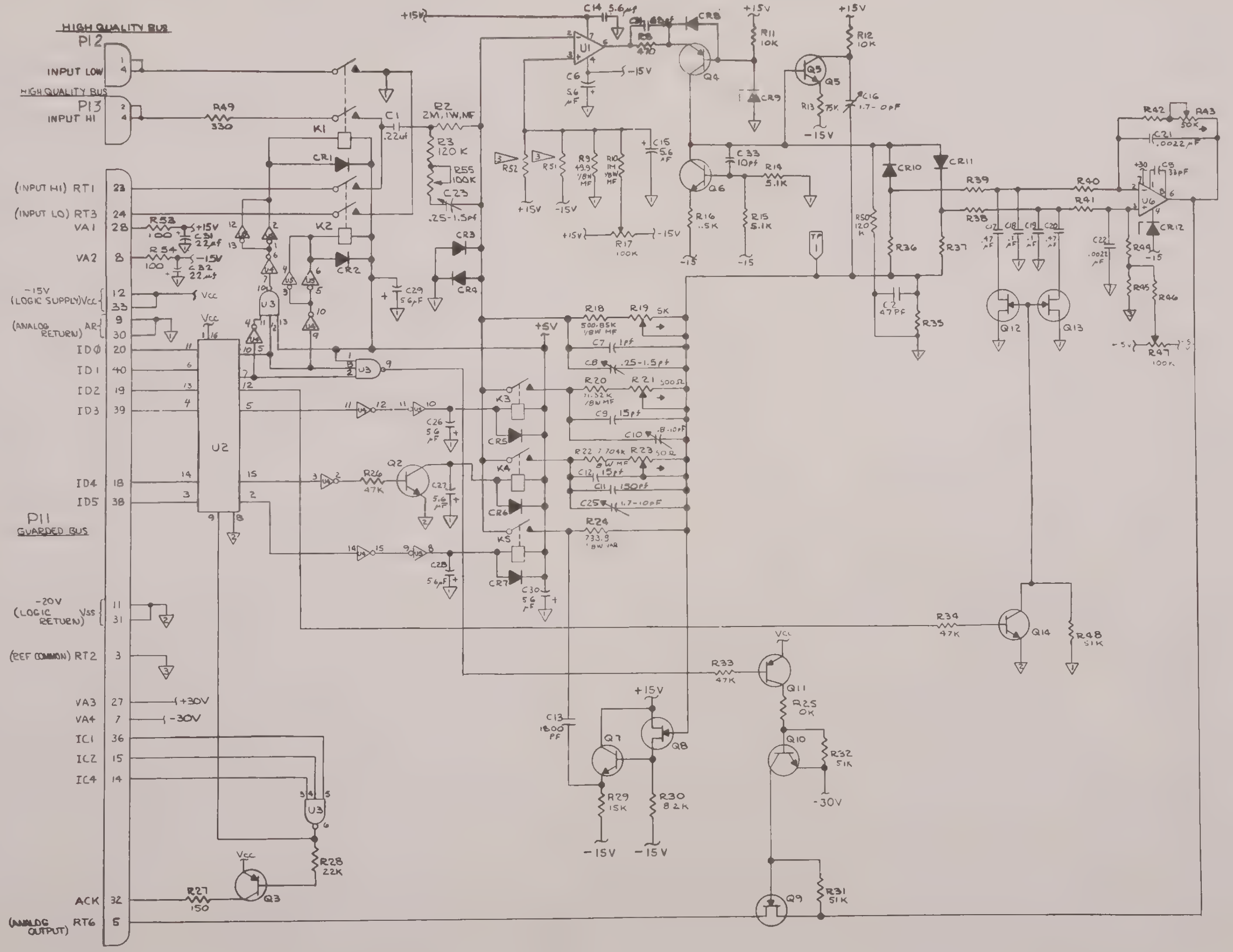

MP14(REF)
MP14(8)
H3,MP15,MP13
MP4
MP5
MP2
MP8
Option -01 PCB
MP9
MP3
MIS-4101
MP1, CASE ASSEMBLY
MP6
AC/DC CONV AVG
MIS-1701

Figure 601-3. AC/DC (Avg) PCB Assembly


HIGH QUALITY BUS
P12
INPUT LOW
HIGH QUALITY BUS
P13
INPUT HI
R49 330
K1
C1 .22uf
R2 2M, 1W, MF
R3 120 K
R55 100K
C23 .25-1.5pf
CR1
CR2
CR3
CR4
K2
C29 5.6 uF
(INPUT HI) RT1
(INPUT LO) RT3
VA1
VA2
R53 100
R54 100
+15V
-15V
C31 22uf
C32 22uf
-15V (LOGIC SUPPLY) Vcc
(ANALOG RETURN) AR
ID0
ID1
ID2
ID3
ID4
ID5
P11 GUARDED BUS
-20V (LOGIC RETURN) Vss
(REF COMMON) RT2
VA3
VA4
+30V
-30V
IC1
IC2
IC4
ACK
(ANALOG OUTPUT) RT6
U2
U3
Vcc
R26 47K
Q2
C26 5.6 uF
C27 5.6 uF
C28 5.6 uF
K3
K4
K5
CR5
CR6
CR7
C30 5.6 uF
+5V
C14 5.6uf
C4 68pf
R8 470
CR8
U1
C6 5.6 uF
Q4
R11 10K
R12 10K
CR9
Q5
R13 75K
C16 1.7-10pF
R52
R51
R9 49.9 1/8W MF
R10 1M 1/8W MF
C15 5.6 uF
R17 100K
C33 10pf
R14 5.1K
Q6
R16 5.1K
R15 5.1K
TP 1
CR10
CR11
R50 120K
R36
R37
C7 47PF
R35
R18 500.85K 1/8W MF
R19 5K
C7 1pf
C8 .25-1.5pf
R20 71.32K 1/8W MF
R21 500Ω
C9 15pf
C10 .8-10pF
R22 7.704K 1/8W MF
R23 50Ω
C12 15pf
C11 150pf
C25 1.7-10pF
R24 733.3 1/8W MF
R39
R38
R40
R41
C17 .47 uF
C18 .1 uF
C19 .1 uF
C20 .47 uF
C22 .0022 uF
R42
R43 50K
C21 .0022uF
C5 33pF
U6
CR12
R44
R45
R46
R47 100K
Q12
Q13
R34 47K
Q14
R48 51K
R33 47K
Q11
R25 0K
Q10
R32 51K
-30V
C13 1800 PF
Q7
Q8
R29 15K
R30 82K
-15V
-15V
Q9
R31 51K
U3
R28 22K
R27 150
Q3

I.C NOS	TYP	VSS	VCC
U2	74C174	8	16
U3	4023	7	14
U4	4050	8	1
U5	7416	7	4

NOTES: (UNLESS OTHERWISE SPECIFIED)

1. ALL RESISTORS 1/4W CC, ALL RESISTANCE IN OHMS.

2▷ MATCHED RESISTOR SET.

3▷ FACTORY SELECTED PARTS

MIS-1101

Figure 601-3. AC/DC Converter (Averaging) PCB Assembly (cont)

Option -02A
Ohms Converter

602A-1. INTRODUCTION

602A-2. Installation of the Ohms Converter provides precision resistance measurement capability. Both two-terminal and four-terminal measurements may be made.

602A-3. SPECIFICATIONS

602A-4. Table 602A-1 lists the specifications for the Ohms Converter.

602A-5. INSTALLATION

602A-6. Refer to Section 4 of this manual under Module Installation and Removal for instructions on installing and removing modules. Section 8 provides a list of permissible and preferred installation slots.

602A-7. OPERATING NOTES

602A-8. Operation of the front panel controls with the Ohms Converter installed is described in Section 2 of this manual. Eight resistance ranges are available: 10, 100, 1k, 10k, 100k, 1M, 10M and 100M. Manual or auto ranging is available. Figure 602A-1 shows possible connections for both two-wire and four-wire configurations. Four-wire measurements provide maximum accuracy and can be made on the 10, 100, 1k, 10k, and 100k ranges when the Ohms Selector is pushed in (4T IN). Two-wire measurements (Ohms Selector out) can be made on the 1M, 10M, and 100M ranges without affecting accuracy.

602A-9. During normal operation (Calibration mode off), ohms zero can be made by shorting the input test leads to compensate for both multimeter internal drift and lead resistance. The front panel Ohms Selector must be pushed in (4T IN) for four terminal zero corrections or out for two-terminal zero corrections. When Calibration mode is off, zero values are stored in temporary memory. Select the 10Ω range and push the ZERO VDC/OHMS button. This zero value is then applied to the selected range (10Ω) and all higher ranges. If greater measurement accuracy is desired, discrete zero values can be stored by subsequently pushing ZERO VDC/OHMS twice in each higher range (lowest to highest). Zero values entered in this fashion do not affect other zero values already entered into Calibration Memory during software calibration. If a power-up or reset occurs with Calibration mode off, the temporary values entered with the above procedure are replaced with the Calibration Memory values.

602A-10. Zero values stored with Calibration mode on are permanently stored in Calibration Memory. This procedure differs in that corrections are made only for multimeter internal drift and the zero value is entered for the selected range only. Refer to Software Calibration (Appendix 7B) for a full description. The temporary value (Calibration mode off) or the permanent value (Calibration mode on) for the range selected can be recalled by pushing RECALL ZERO VDC/OHMS.

602A-11. GUARDING

602A-12. The ohms guard connection is only available through the rear input connector. Figure 602A-1 shows optimal use of the guard. Basically, the ohms guard is used to minimize leakage resistance between HI and LO input leads. This leakage would appear as shunt resistance across high Rx values. In some high-resistance measurement set-ups, leakage resistance in or on the surface of insulating materials may provide enough shunt resistance to degrade the accuracy of the measurement. Figure 602A-1 illustrates one such case. Connecting the ohms guard to the metal plate on which the standoffs are mounted reduces the affect of leakage resistance through or on the standoffs.

602A-13. THEORY OF OPERATION

602A-14. The function of the Ohms Converter is to produce a current through an unknown resistance such that the voltage across the unknown is proportional to the value of resistance. This is accomplished by configuring the unknown resistance, Rx, as the feedback element of an operational amplifier. A reference voltage, VREF, is

Table 602A-1. Ohms Converter Specifications

Input Characteristics

RANGE	FULL SCALE 5½ DIGITS	RESOLUTION		CURRENT THROUGH UNKNOWN
		6½ DIGITS*	5½ DIGITS	
10Ω	20.0000Ω	10 μΩ	100 μΩ	10 mA
100Ω	200.000Ω	100 μΩ	6½ Digits Only	10 mA
1 kΩ	2.00000 kΩ	1 mΩ		1 mA
10 kΩ	25.0000 kΩ	10 mΩ		78 μA
100 kΩ	250.000 kΩ	100 mΩ		7.2 μA
1 MΩ	4.10000 MΩ	1Ω	10Ω	4.5 μA
10 MΩ	35.0000 MΩ	10Ω	100Ω	0.45 μA
100 MΩ	265.000 MΩ	100Ω	1 kΩ	56 nA

*In normal operating mode, 5½ or 6½ digits depending on range. In AVG operating mode, 6½ digits on all ranges.

Accuracy

±(% of Reading + Number of Counts)*		
RANGE	24-HOUR 23°C ±1°C	90-DAY 23°C ±5°C
10Ω	0.003 + 20	0.005 + 20
100Ω	0.002 + 1.4	0.003 + 1.4
1 kΩ	0.002 + 0.8	0.003 + 0.8
10 kΩ	0.002 + 0.8	0.003 + 0.8
100 kΩ	0.002 + 0.8	0.003 + 0.8
1 MΩ	0.002 + 0.8	0.003 + 0.8
10 MΩ	0.0075 + 0.8	0.02 + 0.8
100 MΩ	0.026 + 0.8	0.05 + 1

*With 5½ digit display. For 6½ digit display, multiply Number of Counts by 10.

>90 DAY: 23°C ±5°C
ADD TO THE 90 DAY SPECIFICATION PER MONTH THE FOLLOWING % OF READING

RANGE	% OF READING
10Ω	0.00056
100Ω - 1 MΩ	0.00033
10 MΩ	0.0022
100 MΩ	0.0056

Table 602A-1. Ohms Converter Specifications (cont)

Operating Characteristics

TEMPERATURE COEFFICIENT

±(% OF READING + NUMBER OF COUNTS) /°C*	
RANGE	0°C TO 18°C AND 28°C TO 50°C
10Ω	0.0008 + 1.5
100Ω	0.0007 + 0.2
1 kΩ	0.0007 + 0.2
10 kΩ	0.0007 + 0.2
100 kΩ	0.0007 + 0.5
1 MΩ	0.001 + 0.5
10 MΩ	0.005 + 0.5
100 MΩ	0.02 + 0.5

*With 5½ digit display. For 6½ digit display, multiply Number of Counts by 10.

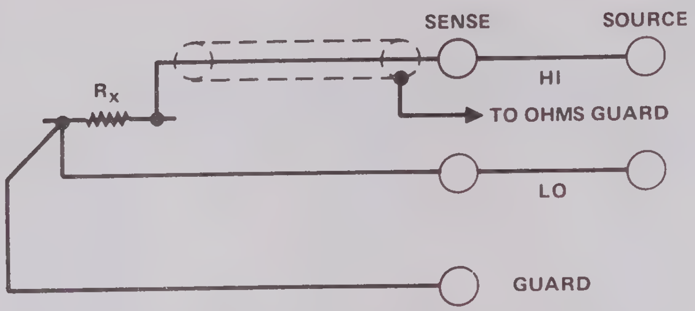
MAXIMUM LEAD RESISTANCE

RANGE	MODE	LEADS	LEAD RESISTANCE
10Ω - 100Ω	4 wire	Source	10Ω
1 kΩ	4 wire	Source	100Ω
10 kΩ - 100 MΩ	4 wire	Source	1 kΩ

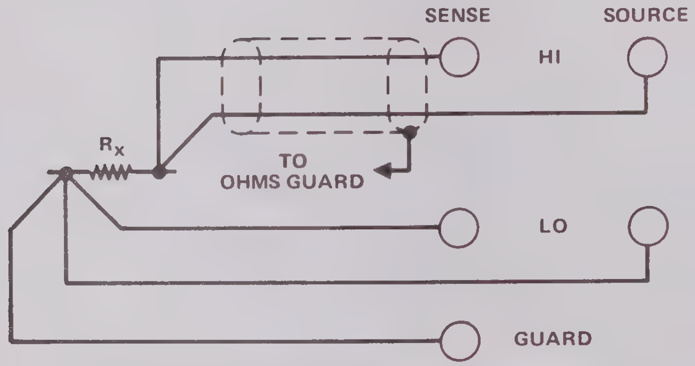
OPEN CIRCUIT VOLTAGE

RANGE	VOLTAGE
10Ω - 100 kΩ	7 volts maximum
1 MΩ - 100 MΩ	25 volts maximum

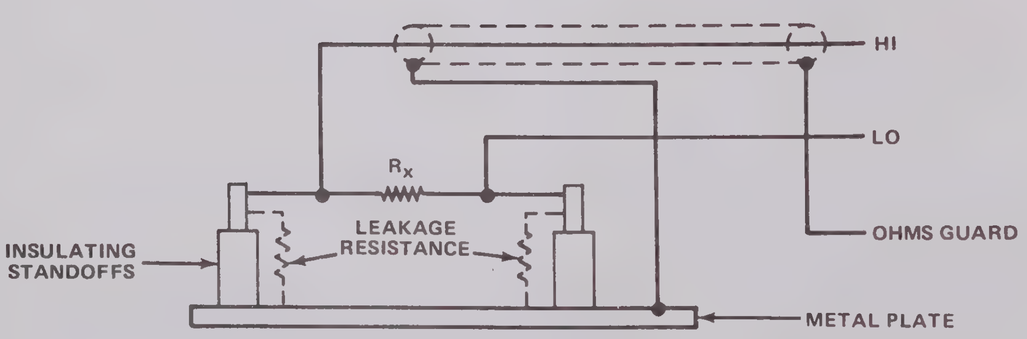
MEASUREMENT CONFIGURATION	Two-wire and four-wire available on all ranges.
MAXIMUM OVERLOAD VOLTAGE	±400V dc or peak ac continuous on any range with no damage.
RESPONSE TIME	
Analog Settling Time	80 ms with Fast Filter or 800 ms with Slow Filter to rated accuracy.
Digitizing Time	Depending on sample rate and filter selection the digitizing time will vary from 145 ms to 9 minutes 6 seconds using a 60 Hz ac line with times increasing 20% using a 50 Hz ac line.


SENSE
SOURCE
R_x
HI
TO OHMS GUARD
LO
GUARD

TWO TERMINAL OHMS MEASUREMENT CONNECTIONS TO MAXIMIZE THE EFFECTIVENESS OF THE GUARDS


SENSE
SOURCE
HI
R_x
TO
OHMS GUARD
LO
GUARD

FOUR TERMINAL OHMS MEASUREMENT CONNECTIONS TO MAXIMIZE THE EFFECTIVENESS OF THE GUARDS


HI
LO
R_x
OHMS GUARD
INSULATING
STANDOFFS
LEAKAGE
RESISTANCE
METAL PLATE

OHMS GUARD IS AVAILABLE ONLY THROUGH THE REAR INPUT CONNECTOR

Figure 602A-1. Ohms Measurement Connections And Guarding

applied through a reference resistor, R_{REF}, to the summing node of the amplifier. By definition of an ideal operational amplifier, the current through R_X is the same current flowing through R_{REF} (the summing node represents virtual ground). Figure 602A-2 is a simplified schematic of the Ohms Converter and contains an illustration of the derivation of the formula for R_X. A current flowing through R_{REF} equals $(V_1-V_2)/R_{REF}$. Using the expression for current to obtain the value of R_X:

$$R_X = R_{REF}\left(\frac{V_0}{V_1-V_2}\right)$$

The Ohms Converter multiplexes the voltages which, after being routed through the DC Signal Conditioner and Filter modules, are measured by the A/D Converter.

602A-15. The current reference for the Ohms Converter is derived from the -7V reference (RT4) from the A/D Converter. Inverting amplifier U4 uses two possible feedback paths to produce either approximately +1.86V or +18.5V as V_1. U4 drives Q8. Q8 serves as a larger current source than is available from U4. R41, R45, and R56 are the reference resistors, each having an adjustment.

602A-16. R_X is the feedback element for the operational amplifier composed of Q9 and U5. U5 drives Q37 which serves as a higher current source. This arrangement also allows a larger output voltage swing. Note that Q9 and U5 are configured as an inverter, yet the output of U5 is a positive voltage. Q37 draws its emitter current through R48 and R49 from the -30V supply with CR18 and CR13 ensuring that Q37 need not be in a state of saturation. SOURCE voltages out are negative voltages at SOURCE LO with respect to circuit common. In the 100M range, the voltage applied to R41 is divided by 8. However, the unattenuated V_{REF} is measured. The factor of 8 is preserved by assigning R_{REF} the value of 8 x R41 in the equation. As the Ohms Converter downranges, R41 remains enabled so lower R_{REF} values are actually parallel combinations. V_2 is not measured in the three highest ranges (1M, 10M, 100M) since lead resistance is not large enough to affect accuracy.

602A-17. Extensive overvoltage protection has been provided for the Ohms Converter. Refer to the full schematic. Voltages appearing on the SENSE or SOURCE HI terminals in excess of +28V or -3V (with respect to circuit common) are clamped to ground by Q14, CR7, Q10, and Q39. U5 is configured as a voltage comparator biased by CR19 and R14. The clamping action of Q14 or Q10 causes a voltage on the input Lo line which triggers comparator U5 through Q11 or Q15. In either case, the output at U5 pin 7 toggles to its maximum positive level, clocking U3 while placing a high on the ID3 line. This opens relay K1 and removes the input voltages from the module. The high from U5 also inhibits the ACK logic so an Error 4 is displayed. CR13 and CR14 at the output of Q9, U5 are high voltage blocking diodes. E1 is a spark gap preventing voltages in excess of 400V between the guard shield and circuit common.

602A-18. The Ohms Converter is addressed by IC1, 2, 3 high, and must be addressed for each sample voltage. Samples are multiplexed out at the rate of one every four msec. This requires the fastest response time in the DC Signal Conditioner of any measurement mode.

602A-19. MAINTENANCE

602A-20. Performance Test

602A-21. Test the Ohms function using the following procedure:

1. Connect test leads to the instrument in the four-wire configuration. Ensure that the front panel Ohms Selector is pushed in (4T IN).

2. Select OHMS (function) and 10Ω manual (range).

3. Short all leads together, then push ZERO VDC/OHMS.

4. Connect the standard resistor for the range selected. Check that the UUT reading falls within the limits specified in Table 602A-2.

5. Select the next higher manual range.

6. Repeat steps 3, 4, and 5 for the 100, 1k, 10k, and 100k ranges.

7. Connect test leads in the two-wire configuration (Ohms Selector out).

8. Repeat steps 3, 4, and 5 for the 1M, 10M, and 100M ranges.

Table 602-2. Performance Test

Standard Resistor	UUT Reading	
	Low (exponent)	High (exponent)
10	9.9975	10.0025
100	99.995	100.005
1K	.99996 (+3)	1.00004 (+3)
10K	9.9996 (+3)	10.0004 (+3)
100K	99.996 (+3)	100.004 (+3)
1M	.99996 (+6)	1.00004 (+6)
10M	9.9979 (+6)	10.0021 (+6)
100M	99.949 (+6)	100.051 (+6)

602A-22. Calibration

602A-23. Use the following procedure for hardware calibration of the Ohms Converter.

1. Allow for a two hour warm-up, then ensure that dc volts accuracy is within tolerance.

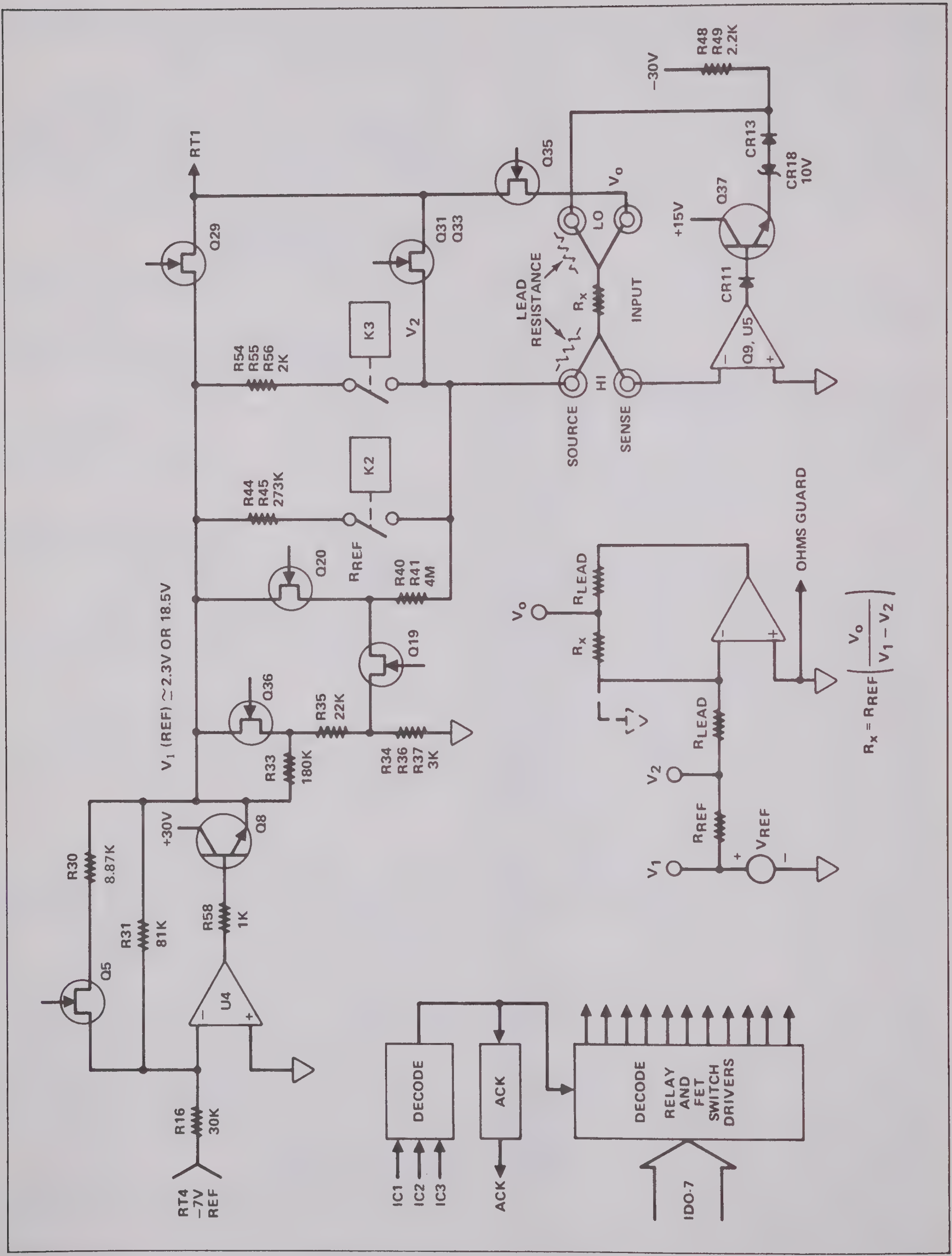

RT4
-7V
REF
R16
30K
U4
Q5
R30
8.87K
R31
81K
R58
1K
+30V
Q8
V1 (REF) ≈ 2.3V OR 18.5V
R33
180K
Q36
R35
22K
R34
R36
R37
3K
Q19
Q20
RREF
R40
R41
4M
R44
R45
273K
K2
R54
R55
R56
2K
K3
V2
Q29
RT1
Q31
Q33
Q35
Vo
LEAD
RESISTANCE
Rx
LO
HI
SOURCE
SENSE
INPUT
-30V
R48
R49
2.2K
CR13
CR18
10V
Q37
+15V
CR11
Q9, U5
Vo
RLEAD
Rx
OHMS GUARD
RLEAD
V2
RREF
V1
VREF
Rx = RREF (Vo / (V1 - V2))
DECODE
ACK
DECODE
RELAY
AND
FET
SWITCH
DRIVERS
IC1
IC2
IC3
ACK
IDO-7

Figure 602A-2. Ohms Converter

2. With the Calibration Switch set to on (AVG/(CAL) annunciator flashes), disable software calibration gain factors by pushing STORE (CAL COR) once for each of the eight ohms ranges.

3. Ensure that the Zero mode is off (ZERO annunciator off). If necessary, toggle the ZERO VDC/OHMS button.

4. Ensure that the Ohms Selector and the Guard Selector are both pushed in. Then apply a high-quality, low-thermal short to the inputs in a four-terminal configuration.

5. Use manual range selection to prevent range changes while testing at the range extremities.

6. Select the 10Ω range on the UUT.

7. Adjust R24 for a reading between -0.0003 and +0.0003.

8. Step through the other seven ranges, checking that the reading is 0 ±1 digit on all ranges.

9. Remove the four-terminal short and make four-terminal measurement connections. Select the 1M range and connect the input leads to a 4 MΩ standard resistor.

NOTE

Refer to Table 4-1 of the Instruction Manual for specifications on the Standard Resistors.

10. Adjust R40 for a reading between 3.99998 (+6) and 4.00002 (+6).

11. Select the 100 MΩ range and connect the input leads to a 100 MΩ standard resistor.

12. Adjust R37 for a reading between 99.995 (+6) and 100.005 (+6).

13. Select the 100 kΩ range and connect the input leads to a 250 kΩ standard resistor.

14. Adjust R44 for a reading between 249.998 (+3) and 250.002 (+3).

15. Select the 1 kΩ range and connect the input leads to a 1.9 kΩ standard resistor.

16. Adjust R54 for a reading between 1.89998 (+3) and 1.90002 (+3).

17. Disable the Calibration mode (Calibration Switch to off).

Table 602-3. Calibration Tests

Resistance Standard	Readings		
	Minimum	Nominal	Maximum
10	9.9989	10.0000	10.0011
100	99.997	100.000	100.003
1k	0.99997 (+3)	1.00000 (+3)	1.00003 (+3)
10k	9.9997 (+3)	10.0000 (+3)	10.0003 (+3)
100k	99.997 (+3)	100.000 (+3)	100.003 (+3)
1M	0.99997 (+6)	1.00000 (+6)	1.00003 (+6)
10M	9.9989 (+6)	10.0000 (+6)	10.0011 (+6)
100M	99.969 (+6)	100.000 (+6)	100.031 (+6)

18. Short all four test leads and perform the ohms zero procedure for each range (lowest to highest). Ensure that a reading of all zeros (± 1 digit) is obtained on each range.

19. With Zero mode on, perform the standard resistor tests in Table 602A-3. There are no adjustments for these readings. If any reading exceeds the listed tolerance, the module is faulty.

602A-24. TROUBLESHOOTING

602A-25. Troubleshooting procedures for the Ohms Converter follow the format used for the mainframe instrument. Table 602A-4, Failure Isolation, assures that the problem is in the Ohms Converter. Table 605A-5 lists symptoms and possible failures in the order of probability. Figure 602A-3 shows timing relationships. Tables 602A-6 through 602A-8 give additional troubleshooting procedures.

602A-26. Always remove power before removing or installing a module.

602A-27. PARTS LIST

602A-28. Table 602A-9 is a parts breakdown for the Ohms Converter. Refer to Section 5 of this manual for ordering and use code information.

Table 602A-4. Failure Isolation

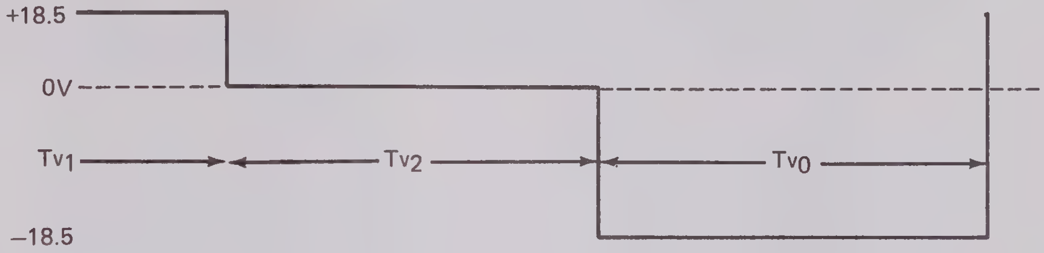
STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Perform DC Volts test (Section 4). Is DC Volts within tolerance?	2	Section 4
2	Perform Ohms test. Is Ohms within tolerance?	Section 4	3
3	Remove all optional modules except Isolator and Ohms converter.		
4	Is Ohms now within tolerance?	5	6
5	An optional module is affecting Ohms. Replace one at a time until Ohms goes bad. Last one in is faulty – go to appropriate portion of Section 6.		
6	Is Isolator installed?	7	9
7	Remove Isolator. Insert Jumper/Monitor pcb. Is Ohms within tolerance:	8	9
8	Bad Isolator. Go to Subsection 608.		
9	Check power supply voltages as follows. Test DMM LO on AR (analog return). VA1 = +14.25 to 15.75V VA2 = –14.25 to –15.75V VA3 = +29 to 32V VA4 = –29 to –32V Vcc = –15V ⎫ Difference = 4.9 Vss = –20V ⎭ to 5.2 RT4 = –6.993 to –7.007		
10	Are the supply voltages within tolerance?	11	Section 4
11	The problem is probably in the Ohms board. However, the DC Signal Conditioner may contribute errors if the slew rates of the amplifiers are not fast enough. Go to Table 602-5.		

Table 602A-5. Symptom Analysis

SYMPTOM	POSSIBLE FAILURE
No Ohms Readings (V_0)	U5, Q9, Q35, Digital Logic
(V_1)	U4, Q8, Q29 Digital Logic & Drivers
Ohms Zero Drift	U5, Q9
10K – 100K Ranges Bad	Q32, Q33, Digital
10 – 100 – 1K Ranges Bad	Q30, Q31, Digital
10M Full Scale Low	Q20, Q22
No ACK	U5, Q14, Q11, Q38
All Ranges Out of Tolerance	Q37, U5
100M Noisy, 30M High	Q10, K3 Shorted
1K, 100K, 10M, 100M Ranges Bad	Q5, Q4
100M Range Bad	Q20, Q22, Q19 Leaky
Display Error 4 with no voltage at input	Q14
Noisy at 30M or Full Scale	CR15, CR17, CR4, CR8
Full Scale 1M, 10M, 100M Ranges Out of Tolerance	CR18
DC SIGNAL CONDITIONER	
Slew Rates Bad	Q37, Q38, Q19, U3, U5, U6

Note: If Q9, Q19, U5, R19, R20, R21, R23, R25, or R26 are replaced it is necessary to return the module to the factory (Attn: Parts) for temperature compensation.

Voltages shown are at RT6, (DC Signal Conditioner Output).



V_o is proportional to R_x, V_o for full scale R_x is shown.

Sample Rate	Filter	Tv_1	Tv_2 *	Tv_0
Fast	No	30ms	30ms	200 ms
Fast	Yes	30ms	30ms	650ms
Slow	No	30ms	30ms	600ms
Slow	Yes	30ms	30ms	1060ms

These are approximate times.

*Except Tv_2 for ranges 1M, 10M, 100M is zero. No V_2 is measured for these ranges.

The first reading after a range change or overrange is modified with longer V_1 and V_2 periods.

Figure 602A-3. Timing

Table 602A-6. Voltage Measurements

Range	Full Scale	V* TP2	R ref	1 ref* (Source HI)	V_0* (Range Value)	V_1* (TP1)	V_2 (Offset)
10	31.25	+18.5V	2K	9.3 mA	.093V	+18.5V	<100 mV
100	250	+18.5V	2K	9.3 mA	.93V	+18.5V	<100 mV
1000	2000	1.86V	2K	0.93 mA	.93V	1.86V	<100 mV
10K	32K	+18.5V	256K	72 μA	.72V	+18.5V	<100 mV
100K	256K	1.86V	256K	7.2 μA	.72V	1.86V	<100 mV
1M	4.091M	+18.5V	4.091M	4.5 μA	4.5V	+18.5V	NA
10M	32.728M	1.86V	4.091M	0.45 μA	4.5V	1.86V	NA
100M	261.824M	1.86V/8	4.091M	56 nA	5.6V	1.86V	NA

*Approximate values (±5%)

TP1 is always -7.0V
TP3 Ref common (use for low side of measurements)
TP4 amplifier offset (<10 μV properly adjusted)
V_0 is proportional to RX
V_2 will vary some with range change

SCANNER: Voltages will appear on RT1 in order. V_0 — V_1 — V_2

Table 602A-7. Range Switch Closures

0 = Switch Open 1 = Switch Closed						Chart applies for time the particular voltage is SCANNED. All other times "0" applies.			
	K1	K2	K3	Q5	Q19	Q20	V_o Q29	V_{2a} Q31	V_{2b} Q33	V_1 Q35
10Ω	1	0	1	0	0	1	1	1	0	1
100Ω	1	0	1	0	0	1	1	1	0	1
1KΩ	1	0	1	1	0	1	1	1	0	1
10KΩ	1	1	0	0	0	1	1	0	1	1
100KΩ	1	1	0	1	0	1	1	0	1	1
1MΩ	1	0	0	0	0	1	1	0	0	1
10MΩ	1	0	0	1	0	1	1	0	0	1
100MΩ	1	0	0	1	1	0	1	0	0	1
OHMS	0	0	0	1	0	1	0	0	0	0

Table 602A-8. Address and Data Coding

ADDRESS IC1, 2, 3 HIGH									
Range	V	IDϕ	ID1	ID2	ID3	ID4	ID5	ID6	ID7
10	V_ϕ	0	1	1	0	0	1	1	0
	V_1	1	0	1	0	0	1	1	0
	V_2	1	1	0	0	0	1	1	0
100	V_ϕ	0	1	1	0	0	1	1	0
	V_1	1	0	1	0	0	1	1	0
	V_2	1	1	0	0	0	1	1	0
1K	V_ϕ	0	1	1	0	1	1	1	0
	V_1	1	0	1	0	1	1	1	0
	V_2	1	1	0	0	1	1	1	0
10K	V_ϕ	0	1	1	0	0	0	1	1
	V_1	1	0	1	0	0	0	1	1
	V_2	1	1	0	0	0	0	1	1
100K	V_ϕ	0	1	1	0	1	0	1	1
	V_1	1	0	1	0	1	0	1	1
	V_2	1	1	0	0	1	0	1	1
1M	V_ϕ	0	1	1	0	0	1	1	1
	V_1	1	0	1	0	0	1	1	1
10M	V_ϕ	0	1	1	0	1	1	1	1
	V_1	1	0	1	0	1	1	1	1
100M	V_ϕ	0	1	1	0	1	1	0	1
	V_1	1	0	1	0	1	1	0	1
OHMS		1	1	1	1	1	1	1	1

Table 602A-9. Ohms Converter PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
-02	OHMS CONVERTER PCB ASSEMBLY FIGURE 602-4 (8505A-4110T)	ORDER	BY	OPTION -02			
C1-C4	CAP, TA, 6.8 UF +/-20%, 35V	363713	56289	196D685X0035KA1	4		
C5	CAP, CER, 33 PF +/-2%, 100V	354852	72982	8121-A100-COG-330G	1		
C6	CAP, CER, 1200 PF +/-20%, 100V	358283	80031	2222-630-01-122	2		
C7	CAP, CER, 1200 PF +/-20%, 100V	358283	80031	2222-630-01-122	REF		
C8	CAP, POLY, 100 PF +/-10%, 500V	446609	89536	446609	1		
C9	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	7		
C10	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C11	CAP, TA, 22 UF +/-20%, 15V	423012	56289	196D226X0015KA1	1		
C12	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C13	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C14	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C15	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C16	CAP, TA, 5.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	1		
C17	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW3COC224K	3		
C18	CAP, TA, 0.47 UF +/-20%, 35V	161349	56289	196D474X0035HA1	1		
C19	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	REF		
C20	CAP, CER, 0.0022 UF +/-10%, 500V	268425	32897	851000Z5R222K	1		
C21	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW3COC224K	REF		
C22	CAP, TA, 0.33 UF +/-20%, 35V	408690	56289	196D334X0035H	1		
C23	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW3COC224K	REF		
CR1	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	6	2	
CR2	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR3	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR4	DIODE, SI, RECTIFIER, 1A	428144	04713	1N4006	7	2	
CR7	DIODE, SI, RECTIFIER, 1A	428144	04713	1N4006	REF		
CR8	DIODE, SI, RECTIFIER, 1A	428144	04713	1N4006	REF		
CR9	DIODE, ZEN, UNCOMP, +/-10%, 10.0V, 400MW	113324	04713	1N961A	2	1	
CR10	DIODE, SI, MULTI-PELLET	375485	09214	MPD300	2	1	
CR11	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR12	DIODE, SI, MULTI-PELLET	375485	09214	MPD300	REF		
CR13	DIODE, SI, RECTIFIER, 1A	428144	04713	1N4006	REF		
CR14	DIODE, SI, RECTIFIER, 1A	428144	04713	1N4006	REF		
CR15	DIODE, SI, RECTIFIER, 1A	428144	04713	1N4006	REF		
CR16	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR17	DIODE, SI, RECTIFIER, 1A	428144	04713	1N4006	REF		
CR18	DIODE, ZEN, UNCOMP, +/-10%, 10.0V, 400MW	113324	04713	1N961A	REF		
CR19	DIODE, 2-PELLET	375477	09214	MPD-200	1	1	
CR20	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
E1	VOLTAGE SURGE PROTECTOR	442723	25088	B2-B470	1		
H1	SCREW, PHP, 4-40 X 5/8	413062	89536	413062	1		
K1	RELAY, ARMATURE	515429	89536	515429	1		
K2	RELAY, DRY REED	357582	71707	UF40070	2		
K3	RELAY, DRY REED	357582	71707	UF40070	REF		
L1	CHOKE, RF	111542	99800	1537-76	1		
MP1	MODULE CASE (Includes MP2-MP9)	651885	89536	651885	1		1
MP2	CASE HALF, MODULE	402990	89536	402990	2		
MP3	CASE HALF, MODULE	402990	89536	402990	REF		

Table 602A-9. Ohms Converter PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
MP4	COVER, MODULE CASE	402974	89536	402974	1		
MP5	SHIELD, COVER	411942	89536	411942	1		
MP6	DECAL, OHMS CONVERTER	650572	89536	650572	1		
MP7	DECAL, CAUTION	454504	89536	454504	1		
MP8	GUARD, REAR	383364	89536	383364	1		
MP9	GUARD, FRONT	383356	89536	383356	1		
MP11	SPACER, XSTR (not shown)	152207	07047	10123-DAP	5		
MP13	LUG, SOLDER	103531	77963	501	1		
MP14	SPRING, COIL	424465	83553	C0120-041-0380	1		
Q1	TRANSISTOR, SI, PNP	226290	04713	MPS3640	1	1	
Q2	TRANSISTOR, SI, NPN	218396	04713	2N3904	14	3	
Q3	TRANSISTOR, SI, PNP	195974	04713	2N3906	7	2	
Q4	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q5	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578	4	1	
Q6	TRANSISTOR, SI, NPN	168716	89536	168716	3	1	
Q7	TRANSISTOR, SI, NPN	168716	89536	168716	REF		
Q8	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q9	TRANSISTOR, FET, DUAL, N-CHANNEL	476309	89536	476309	1	1	
Q10	TRANSISTOR, SI, NPN	203489	09214	11C2322	5	1	
Q11	TRANSISTOR, SI, NPN	203489	09214	11C2322	REF		
Q12	TRANSISTOR, SI, PNP	195974	04713	2N3906	REF		
Q13	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q14	TRANSISTOR, SI, NPN	203489	09214	11C2322	REF		
Q15	TRANSISTOR, SI, NPN	203489	09214	11C2322	REF		
Q16	TRANSISTOR, SI, NPN	203489	09214	11C2322	REF		
Q17	TRANSISTOR, SI, PNP	195974	04713	2N3906	REF		
Q18	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q19	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578	REF		
Q20	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578	REF		
Q21	TRANSISTOR, SI, PNP	195974	04713	2N3906	REF		
Q22	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q23	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q24	TRANSISTOR, SI, PNP	195974	04713	2N3906	REF		
Q25	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q26	TRANSISTOR, SI, PNP	195974	04713	2N3906	REF		
Q27	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q28	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q29	TRANSISTOR, FET, N-CHANNEL	393314	89536	393314	4	1	
Q30	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q31	TRANSISTOR, FET, N-CHANNEL	393314	89536	393314	REF		
Q32	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q33	TRANSISTOR, FET, N-CHANNEL	393314	89536	393314	REF		
Q34	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q35	TRANSISTOR, FET, N-CHANNEL	393314	89536	393314	REF		
Q36	TRANSISTOR, FET, N-CHANNEL	261578	89536	261578	REF		
Q37	TRANSISTOR, SI, NPN	218396	04713	2N3904	REF		
Q38	TRANSISTOR, SI, PNP	195974	04713	2N3906	REF		
Q39	TRANSISTOR, SI, NPN	168716	89536	168716	REF		
Q40	TRANSISTOR, J-FET, N-CHANNEL	288324	89536	288324	1	1	

Table 602A-9. Ohms Converter PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
R1	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	6		
R2	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	6		
R3	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	REF		
R4-R7	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	REF		
R8	RES, COMP, 220K +/-5%, 1/2W	109025	01121	EB2245	1		
R9	RES, COMP, 1.8K +/-5%, 1W	180331	01121	GB1825	2		
R10	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	REF		
R11	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	REF		
R12	RES, COMP, 100K +/-10%, 1W	109397	01121	GB1031	1		
R14	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	1		
R16	RES, MTL. FILM, 30.1K +/-1%, 1/8W	293431	91637	CMF553012F	1		
R17	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	6		
R18	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R19	RES, WW, 40K +/-0.1%	271403	89536	271403	2		
R20	BUSS WIRE, #22AWG	115469	89536	115469	A/R		
R21	RES, MTL. FILM, 10 +/-1%, 1/8W	268789	91637	CMF550100F	2		
R23	BUSS WIRE, #22AWG	115469	89536	115469	REF		
R24	RES, VAR, 100 +/-20%, 1/2W	267823	11236	190PC101B	1		
R25	RES, WW, 40K +/-0.1%	271403	89536	271403	REF		
R26	RES, MTL. FILM, 10 +/-1%, 1/8W	268789	91637	CMF550100F	REF		
R27	RES, MTL. FILM, 20K +/-1%, 1/8W	291872	91637	CMF552002F	1		
R28	RES, DEP. CAR, 39K +/-5%, 1/4W	442400	80031	CR251-4-5P39K	2		
R29	RES, DEP. CAR, 39K +/-5%, 1/4W	442400	80031	CR251-4-5P39K	REF		
R30	RES, MTL. FILM, 8.87K +/-1%, 1/8W	394967	91637	CMF558871F	1		
R31	RES, MTL. FILM, 80.6K +/-1%, 1/8W	312710	91637	CMF558062F	1		
R32	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R33	RES, DEP. CAR, 180K +/-5%, 1/4W	348946	80031	CR251-4-5P180K	1		
R34	RES, MTL. FILM, 3.16K +/-0.1%, 1/8W	340588	91637	CMF553161B	1		
R35	RES, MTL. FILM, 21.5K +/-1%, 1/8W	344440	91637	CMF552152F	1		
R36	RES, MTL. FILM, 100K +/-1%, 1/8W	248807	91637	CMF551003F	1		
R37	RES, VAR, 50K +/-10%, 1/2W	330688	11236	190PC503B	1		
R39	RES, DEP. CAR, 1.6K +/-5%, 1/4W	348805	80031	CR251-4-5P1K6	1		
R40	RES, VAR, 10K +/-20%, 1/2W	267880	11236	190PC103B	1		
R41	RES, WW, 4.091M +/-0.1%, 2W	412205	89536	412205	1		
R42	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	REF		
R43	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R44	RES, VAR, 500 +/-20%, 1/2W	267849	11236	190PC501B	1		
R45	RES, WW, 272.84K +/-0.08%, 1/2W	412197	89536	412197	1		
R46	RES, DEP. CAR, 3.3K +/-5%, 1/4W	348813	80031	CR251-4-5P3K3	1		
R47	RES, DEP. CAR, 120K +/-5%, 1/4W	441386	80031	CR251-4-5P120K	4		
R48	RES, DEP. CAR, 470 +/-5%, 1/4W	343434	80031	CR251-4-5P470E	2		
R49	RES, COMP, 1.8K +/-5%, 1W	180331	01121	GB1825	REF		
R50	RES, DEP. CAR, 2.7K +/-5%, 1/4W	386490	80031	CR251-4-5P2K7	2		
R51	RES, DEP. CAR, 2.7K +/-5%, 1/4W	386490	80031	CR251-4-5P2K7	REF		
R52	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	REF		
R53	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R54	RES, VAR, 200K +/-20%, 1/2W	381509	11236	190PC204B	1		
R55	RES, MTL. FILM, 332K +/-1%, 1/8W	289504	91637	CMF553323F	1		
R56	RES, WW, 2.01K +/-0.1%, 1/2W	412189	89536	412189	1		
R57	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	REF		

Table 602A-9. Ohms Converter PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
R58	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	2		
R59	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	REF		
R60	RES, MTL. FILM, 1M +/-1%, 1/8W	268797	91637	CMF551004F	1		
R61	RES, DEP. CAR, 120K +/-5%, 1/4W	441386	80031	CR251-4-5P120K	REF		
R62	RES, DEP. CAR, 120K +/-5%, 1/4W	441386	80031	CR251-4-5P120K	REF		
R63	RES, MTL. FILM, 15.8K +/-1%, 1/8W	293688	91637	CMF551582F	1		
R64	RES, MTL. FILM, 73.2K +/-1%, 1/8W	237222	91637	CMF557322F	1		
R65	RES, MTL. FILM, 30.1K +/-1%, 1/8W	168286	91637	CMF553012F	1		
R66	RES, DEP. CAR, 120K +/-5%, 1/4W	441386	80031	CR251-4-5P120K	REF		
R67	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R68	RES, DEP. CAR, 560K +/-5%, 1/4W	342642	80031	CR251-4-5P560K	1		
R69	RES, DEP. CAR, 300 +/-5%, 1/4W	441519	80031	CR251-4-5P300E	1		
R70	RES, DEP. CAR, 200K +/-5%, 1/4W	441485	80031	CR251-4-5P200K	1		
R71	RES, DEP. CAR, 470 +/-5%, 1/4W	343434	80031	CR251-4-5P470E	REF		
TP1-TP4	TERMINAL, TEST POINT	179283	89536	179283	4		
TP1-TP4	TERMINAL, TEST POINT	179283	89536	179283	4		
U1	⊗ IC, CMOS, TRIPLE 3-INPUT NAND GATE	375147	02735	CD4023AE	1	1	
U2	⊗ IC, CMOS, QUAD CLOCKED D LATCH	355149	02735	CD4042AE	2	1	
U3	⊗ IC, CMOS, QUAD CLOCKED D LATCH	355149	02735	CD4042AE	REF		
U4	IC, LIN, OPERATIONAL AMPLIFIER	363515	12040	LM301	1	1	
U5	IC, LIN, OPERATIONAL AMPLIFIER	418566	12040	LM358N	1	1	
U6	RESISTOR NETWORK	380618	89536	380618	2	1	
U7	RESISTOR NETWORK	380618	89536	380618	REF		
XR20	SOCKET, COMPONENT LEAD	343285	00779	2-331272-6	8		
XR21	SOCKET, COMPONENT LEAD	343285	00779	2-331272-6	REF		
XR23	SOCKET, COMPONENT LEAD	343285	00779	2-331272-6	REF		
XR26	SOCKET, COMPONENT LEAD	343285	00779	2-331272-6	REF		

1 ORDER P/N 458927 TO ORDER COMPLETE MODULE CASE, WITHOUT PCB ASSY.

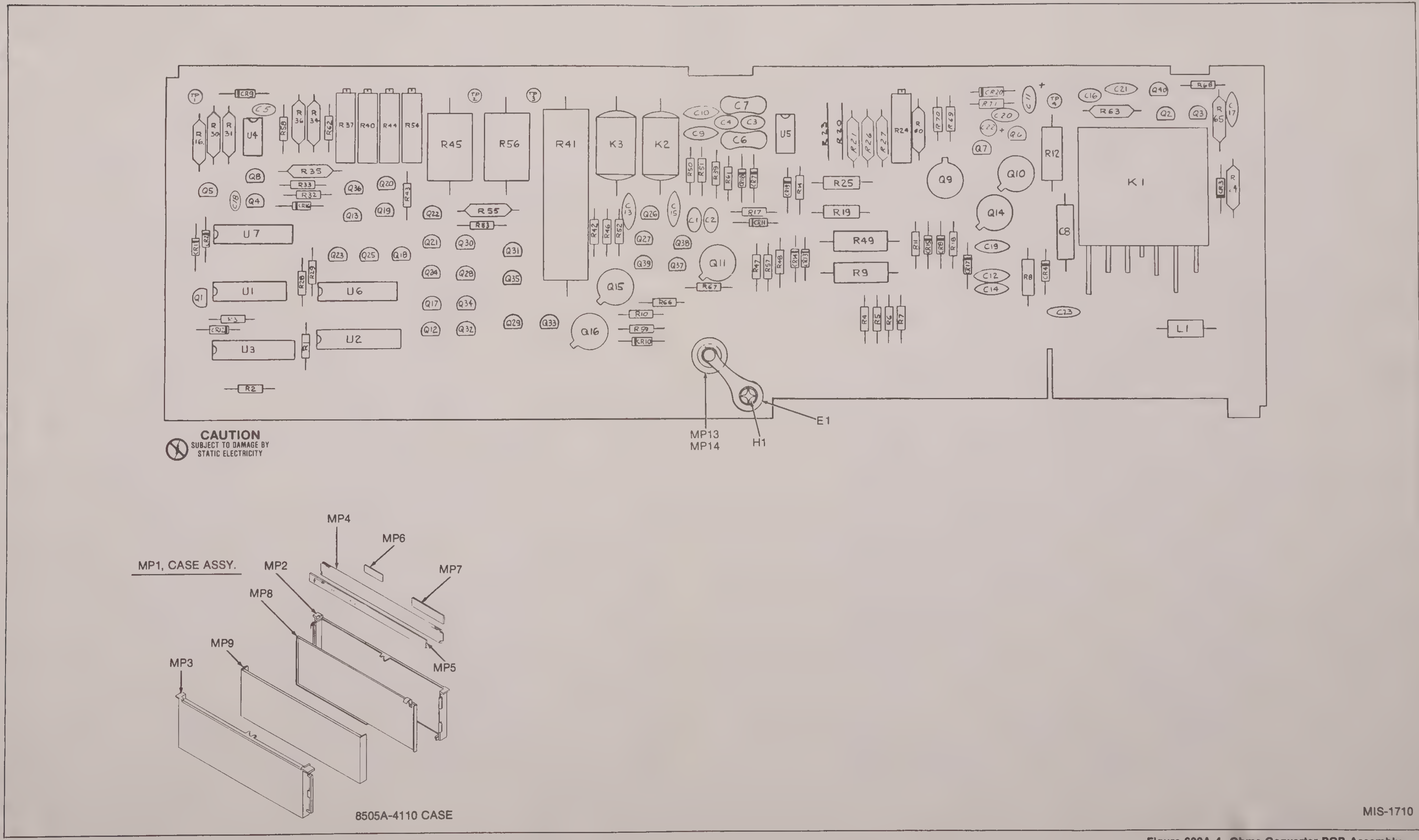

TP1
CR9
C5
R16
R30
R31
U4
R58
R36
R34
R62
R37
R40
R44
R54
TP2
TP3
R45
R56
R41
K3
K2
C10
C7
C4
C3
C9
C6
U5
R22
R30
R21
R26
R27
R24
R80
R70
R69
CR20
R71
C11
C20
C22
Q6
TP4
C16
C21
Q40
R68
R63
Q2
Q3
R65
C17
Q7
R12
K1
R35
Q8
R33
R32
CR16
Q5
C18
Q4
Q36
Q20
R43
Q13
Q19
Q22
R55
R83
R50
R51
R39
R61
C13
Q26
C15
C1
C2
R25
R19
Q9
Q10
Q14
R17
CR11
R14
CR3
R4
U7
CR1
R22
R42
R46
R52
Q27
Q38
Q23
Q25
Q18
Q21
Q30
Q31
Q11
R49
R9
C19
C8
R11
R15
R18
R13
R47
R57
R48
CR14
CR13
Q39
Q37
C12
C14
R8
CR4
U1
R28
R29
U6
Q1
Q34
Q28
Q35
Q15
R67
Q17
Q34
R66
R10
R59
CR10
R4
R5
R6
R7
C23
R3
CR12
Q12
Q32
Q29
Q33
Q16
U2
U3
R1
L1
R2
CAUTION
SUBJECT TO DAMAGE BY
STATIC ELECTRICITY
MP13
MP14
H1
E1
MP1, CASE ASSY.
MP4
MP6
MP2
MP7
MP8
MP9
MP3
MP5
8505A-4110 CASE
MIS-1710

Figure 602A-4. Ohms Converter PCB Assembly

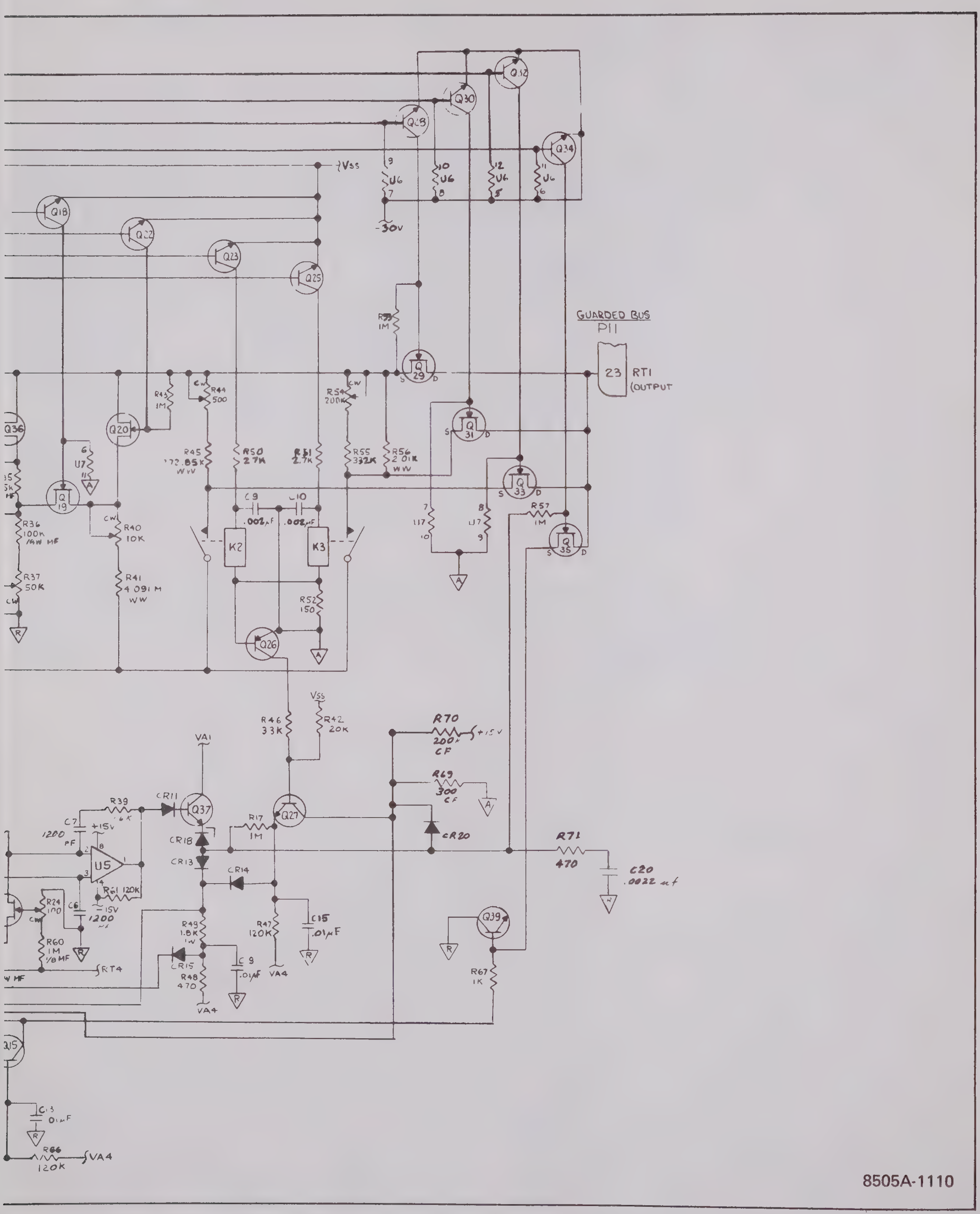

Q32
Q30
Q28
Q34
Vss
9 U6 7
10 U6 8
12 U6 5
11 U6 6
-30V
Q18
Q22
Q23
Q25
R53 1M
GUARDED BUS
P11
23 RT1 (OUTPUT)
Q29
S
D
R43 1M
CW R44 500
CW R54 200K
Q36
Q20
Q31
R45 172.85K WW
R50 2.7K
R51 2.7K
R55 332K
R56 2.01K WW
6 U7 11
Q19
Q33
C9 .002µF
C10 .002µF
K2
K3
R57 1M
Q35
R36 100K 1/4W MF
CW R40 10K
7 U7 10
8 U7 9
R37 50K CW
R41 4.091M WW
R52 150
Q26
A
R
Vss
R46 33K
R42 20K
R70 200K CF +15V
VA1
R69 300 CF
R39 1.6K
CR11
Q37
Q27
C7 1200 PF
+15V
R17 1M
CR18
CR20
R71 470
CR13
U5
CR14
C20 .0022 µf
R61 120K
-15V
C6 1200
R24 100
C15 .01µF
Q39
R49 1.8K 1W
R47 120K
R60 1M 1/8MF
C9 .01µF
VA4
RT4
CR15
R48 470
R67 1K
Q15
C13 .01µF
R66 120K
VA4
8505A-1110

Figure 602A-9. Ohms Converter PCB Assembly (cont)

Option —03
Current Shunts

603-1. INTRODUCTION

603-2. Installation of the Current Shunts module allows for current measurement in five ranges: 100 μA, 1 mA, 10 mA, 100 mA, and 1A. The 8506A DMM has dc current capability only. All other 8500 Series DMM's have both dc and ac current capabilities. For any of these DMM's, ac current measurements require installation of one of the ac converter options.

CAUTION

Selection of the autorange mode when using a constant current power source, e.g. the Fluke 3330B Constant Current Mode, can result in excessive voltage overloads. The overload results from the momentary open circuit at the DMM input terminals when ranging into or out of the 100 μA or 1A range. Constant voltage power sources are not affected.

603-3. SPECIFICATIONS

603-4. Table 603-1 lists the specifications for the Current Shunts module. These specifications cover both dc and ac current. All ac current specifications are not applicable to the 8506A. This DMM has dc current measurement capability only. All dc current specifications apply to any 8500 Series DMM. All references to the "6-1/2 digit display" apply to the 8505A and 8506A DMM's.

603-5. INSTALLATION

603-6. Refer to Section 4 of this manual under Module Installation and Removal for instructions on installing the Current Shunts module. The interconnect diagram in Section 8 contains a table listing permissible and preferred slots.

603-7. OPERATING NOTES

603-8. Operation of the front panel switches is the same as described in Section 2 of this manual. Inputs to the Current Shunts module are between Source HI and Source LO. Sense HI and Sense LO may be left connected with the shorting links provided.

NOTE

Position sensitivity of switches requires that the instrument be operated within 30° of its horizontal position.

603-9. THEORY OF OPERATION

603-10. The function of the Current Shunt module is to generate a voltage proportional to the current to be measured. Outputs from the Current Shunt module are applied either to the DC Signal Conditioner for dc currents or to an optional ac converter for ac currents.

603-11. Two modes of operation are used in the Current Shunt module, depending on the range selected. Figure 603-1 illustrates the two configurations and contains tables relating resistors, switches, and relays to each range. Mode A is used for the 100 μA, 1 mA, and 10 mA ranges. Input currents are applied to the summing node (virtual ground) of an operational amplifier through R4. R4 ensures stability when the current source is highly capacitive, while presenting a very low voltage burden. The formula given for determining floor digits (uncertainty) in the accuracy specifications is based on the feedback resistors used in the three lowest ranges. For source resistances less than approximately 10 x $R_{FEEDBACK}$, the gain of the circuit becomes greater than one for error sources such as offset voltages and current noise. Thus the basic uncertainty (digits) of a measurement increases as the source resistance decreases. The output voltage is equal to the input current multiplied by $R_{FEEDBACK}$.

Table 603-1. Current Shunts Specifications

Input Characteristics

RANGE	FULL SCALE 5½ DIGITS		RESOLUTION*		VOLTAGE BURDEN
	DC	AC³	6½ DIGIT	5½ DIGIT	
100 μA	250.000 μA	312.500 μA	0.1 nA	1 nA	<=100 mV
1 mA	2.00000 mA	2.50000 mA	1 nA	10 nA	<=100 mV
10 mA	16.0000 mA	20.0000 mA	10 nA	100 nA	<=200 mV
100 mA	128.000 mA	160.000 mA	100 nA	1 μA	<=200 mV
1A	1.28000A	1.28000A	1 μA	10 μA	<=500 mV

*6½ digit resolution in AVG operating mode (8505A/8506A), 100 μA ac range is 5½ digits only.

DC Current Accuracy ±(% OF READING + NUMBER OF COUNTS)*

RANGE	24 HOUR 23°C ±1°C	90 DAY 23°C ±5°C	AT SOURCE RESISTANCE¹
100 μA	0.02 + 10	0.03 + 10	>=80 kΩ
1 mA	0.02 + 10	0.03 + 10	>=10 kΩ
10 mA	0.02 + 10	0.03 + 10	>=1.25 kΩ
100 mA	0.03 + 20	0.05 + 20	>=40Ω
1A	0.03 + 20	0.05 + 20	>=10Ω

*With 5½ digit display. For 6½ digit display multiply Number of Counts by 10.

>90 DAY 23°C ±5°C
ADD TO THE 90 DAY SPECIFICATIONS PER MONTH THE FOLLOWING % OF READING

RANGE	% OF READING
100 μA	0.0022
1 mA	0.0022
10 mA	0.0022
100 mA	0.0056
1A	0.0056

AC Current Accuracy ±(% OF READING + NUMBER OF COUNTS)³

24 HOUR 23°C ±1°C*

RANGE	FREQUENCY	AVERAGE RESPONDING OPTION -01	TRUE RMS OPTION -09A
100 μA	10 Hz-20 Hz	—	0.7 + 110
	20 Hz-50 Hz	0.55 + 9	0.55 + 35
	50 Hz-10 kHz	0.3 + 9	0.28 + 35
	10 kHz-20 kHz	0.5 + 9	0.7 + 110
	20 kHz-50 kHz	1.0 + 9	1.0 + 260
	50 kHz-100 kHz	2.0 + 9	2.8 + 760
1 mA and 10 mA	10 Hz-20 Hz	—	0.7 + 110
	20 Hz-50 Hz	0.35 + 9	0.35 + 35
	50 Hz-10 kHz	0.05 + 9	0.08 + 35
	10 kHz-20 kHz	0.08 + 9	0.14 + 110
	20 kHz-50 kHz	0.08 + 9	0.2 + 260
	50 kHz-100 kHz	0.35 + 9	0.7 + 760
100 mA	10 Hz-20 Hz	—	0.7 + 150
	20 Hz-50 Hz	0.34 + 55	0.35 + 80
	50 Hz-10 kHz	—	0.18 + 80
	50 Hz-100 kHz	0.16 + 55	—
1A	10 Hz-20 Hz	—	0.07 + 160
	20 Hz-50 Hz	0.34 + 65	0.35 + 90
	50 Hz-10 kHz	0.16 + 65	0.18 + 90

*With 5½ digit display. For 6½ digit display, multiply Number of Counts by 10. Same source resistance as dc current.

Table 603-1. Current Shunts Specifications (cont)

AC Current Accuracy (cont)[3]

90 DAY 23°C ±5°C*

RANGE	FREQUENCY	AVERAGE RESPONDING OPTION -01	TRUE RMS OPTION -09A
100 µA	10 Hz-20 Hz	—	1.0 + 110
	20 Hz-50 Hz	0.8 + 9	0.8 + 35
	50 Hz-10 kHz	0.4 + 9	0.4 + 35
	10 kHz-20 kHz	0.7 + 9	1.0 + 110
	20 kHz-50 kHz	1.5 + 9	1.5 + 260
	50 kHz-100 kHz	3.0 + 9	4.0 + 760
1 mA and 10 mA	10 Hz-20 Hz	—	1.0 + 110
	20 Hz-50 Hz	0.5 + 9	0.5 + 35
	50 Hz-10 kHz	0.06 + 9	0.11 + 35
	10 kHz-20 kHz	0.11 + 9	0.2 + 110
	20 kHz-50 kHz	0.12 + 9	0.3 + 260
	50 kHz-100 kHz	0.51 + 9	1.0 + 760
100 mA	10 Hz-20 Hz	—	1.0 + 150
	20 Hz-50 Hz	0.5 + 55	0.5 + 80
	50 Hz-10 kHz	—	0.26 + 80
	50 Hz-100 kHz	0.24 + 55	—
1A	10 Hz-20 Hz	—	1.0 + 160
	20 Hz-50 Hz	0.5 + 65	0.5 + 90
	50 Hz-10 kHz	0.24 + 65	0.26 + 90

*With 5½ digit display. For 6½ digit display, multiply Number of Counts by 10. Same source resistance as dc current.

>90 DAY 23°C ±5°C*

ADD TO THE 90 DAY SPECIFICATIONS PER MONTH THE FOLLOWING % OF READING

RANGE	FREQUENCY	AVERAGE RESPONDING OPTION -01	TRUE RMS OPTION -09A
100 µA	10 Hz-20 Hz	—	0.11
	20 Hz-50 Hz	0.089	0.089
	50 Hz-10 kHz	0.044	0.044
	10 kHz-20 kHz	0.089	0.11
	20 kHz-50 kHz	0.17	0.17
	50 kHz-100 kHz	0.33	0.44
1 mA and 10 mA	10 Hz-20 Hz	—	0.11
	20 Hz-50 Hz	0.056	0.056
	50 Hz-10 kHz	0.0067	0.012
	10 kHz-20 kHz	0.012	0.022
	20 kHz-50 kHz	0.013	0.033
	50 kHz-100 kHz	0.057	0.11
100 mA	10 Hz-20 Hz	—	0.11
	20 Hz-50 Hz	0.056	0.056
	50 Hz-10 kHz	—	0.029
	50 Hz-100 kHz	0.029	—
1A	10 Hz-20 Hz	—	0.11
	20 Hz-50 Hz	0.056	0.056
	50 Hz-10 kHz	0.029	0.029

Table 603-1. Current Shunts Specifications (cont)

Operating Characteristics

TEMPERATURE COEFFICIENT ±(% OF READING + NUMBER OF COUNTS) /°C*

0°C TO 18°C AND 28°C TO 50°C			
RANGE	DC[2]	TRUE RMS AC[3]	AVERAGE RESPONDING AC[3]
100 μA	0.0025 + 0.6	0.005 + 3.5	0.004 + 1.5
1 mA	0.0025 + 0.6	0.005 + 3.5	0.004 + 1.5
10 mA	0.0025 + 0.6	0.005 + 3	0.004 + 1
100 mA	0.0035 + 0.6	0.005 + 9	0.004 + 7
1A	0.0035 + 0.6	0.005 + 9	0.004 + 7

*With 5½ digits display. For 6½ digits display, multiply Number of Counts by 10.

CREST FACTOR (RMS ac) .... >4.5 at full scale, increasing down scale by $4.5 \times \sqrt{\text{I range / I input}}$

MAXIMUM OVERLOAD .... 1.5A maximum, ±140V dc or peak ac to 60 Hz, or 200V peak ac above 60 Hz on any range with no damage. Protected by a 1.5A fuse.

SETTLING AND DIGITIZING TIME ... Same as dc volts (see Section 1).

NOTES:

[1] For Source Resistance less than specified replace the Number of Counts in the dc Accuracy specification with the following:

RANGE	NUMBER OF COUNTS*
100 μA	9 x (1 + 8 kΩ/Rs)
1 mA	9 x (1 + 1 kΩ/Rs)
10 mA	9 x (1 + 125Ω/Rs)

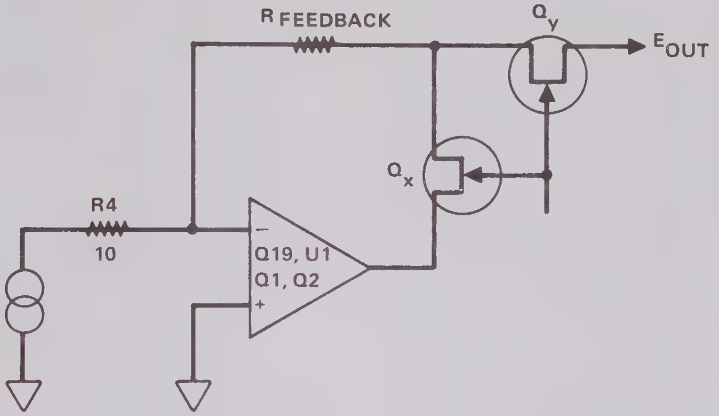
*With 5½ digit display. For 6½ digits, multiply Number of Counts by 10.

[2] For Source Resistance less than specified replace the Number of Counts per °C in the dc Temperature Coefficient specification with the following:

RANGE	NUMBER OF COUNTS /°C*
100 μA	0.5 x (1 + 8 kΩ/Rs)
1 mA	0.5 x (1 + 1 kΩ/Rs)
10 mA	0.5 x (1 + 125Ω/Rs)

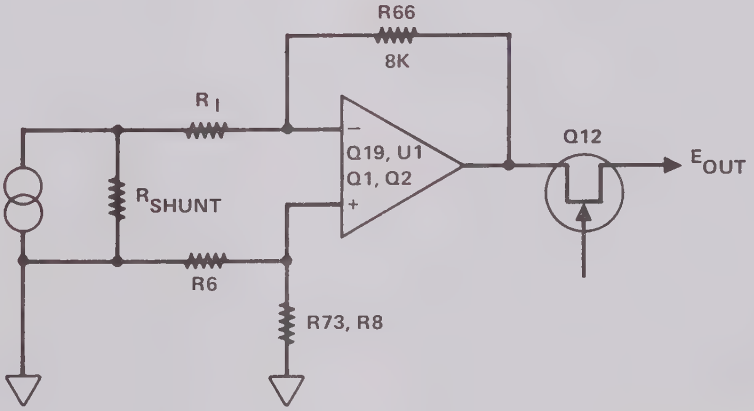
*With 5½ digit display. For 6½ digits, multiply Number of Counts by 10.

[3] AC Current cannot be measured with the 8506A


$R_{FEEDBACK}$
Q_Y
E_{OUT}
Q_X
R4
10
−
Q19, U1
Q1, Q2
+

MODE A — 100 µA, 1 mA, 10 mA

RANGE	$R_{FEEDBACK}$	Q_X	Q_Y	RELAYS	FULL SCALE E_{OUT}
100 µA	R30, R31	Q30	Q31	K3, K4	.8 V
1 mA	R33, R34	Q7	Q10	K3, K4	1.0 V
10 mA	R36, R37	Q9	Q8	K3, K4	1.25 V


R66
8K
R_I
−
Q19, U1
Q1, Q2
+
Q12
E_{OUT}
R_{SHUNT}
R6
R73, R8

MODE B 100 mA, 1A

RANGE	R_{SHUNT}	R_I	RELAYS	FET SWITCHES	FULL SCALE E_{OUT}
100 mA	R2, R1	R7, R70, R71	K1, K3	Q20, Q32, Q29, Q12	1.6V
1 A	R1	R7, R68, R69	K2, K3	Q20, Q29, Q28, Q12	2.0V

Q11 and either Q3 or Q4 will be conducting in all ranges

Figure 603-1. Current Shunt Configurations And Range Information

603-12. Mode B configures the amplifier as a difference amplifier measuring the voltage across a shunt. The ratio of the feedback resistor, R66, to R_I sets the gain of the amplifier at approximately 20 $[R66/R_I = (R8 + R73)/R6]$.

603-13. The amplifier consists of a dual FET (Q19), U1, Q1, and Q2. Refer to the schematic. R18 biases Q19 from the −7V reference (from the A/D Converter). R57 and R58 are selected to compensate for offset error (one of them will always be 10Ω). R55 and R56 are selected for temperature coefficient compensation. Q1 and Q2 are a complementary pair (for either polarity output) to increase the current output capability of the amplifier.

603-14. Q11 and relay K3 are always closed for current measurements. Q3 and Q4 control the ground reference selection for the amplifier. In the dc mode, Q3 connects the noninverting input of the amplifier to reference common. In the ac mode the amplifier is referenced to the ac module ground (RT3) through Q4.

603-15. The Current Shunts module is addressed by IC0, 1, 3 high. At the first address, an ACK is returned and K5 is energized to sample the input voltage. If the voltage exceeds ± 45V, one section of U6 will have a high output, depending on the input polarity. The output from U6 is stored on C10. At the next address the voltage on C10 will prevent the return of the ACK response and will prevent control data from being latched into U2. An Error 4 will be displayed. In addition to overvoltage protection provided by U6, overcurrent protection is provided by CR9 and CR10 in the 100 μA, 1 mA, and 10 mA ranges, and by CR5 and CR6 in the 100 mA and 1 A ranges. A fuse in series with the Source HI terminal is located on the front panel for additional overcurrent protection.

603-16. At the second address, if the input voltage did not exceed ± 45V, termination of the address clocks range and reference control data into U2. Since relay common is Vcc, relay drivers must go low to energize a relay. FET switch drivers are configured to use a low from U2 to turn on the FET (close the switch) by turning off the gate control transistor.

603-17. MAINTENANCE

603-18. Performance Test

603-19. Test the direct current function by using the following procedure.

1. Select ADC and AUTO.
2. Connect the direct current source output HI to the instrument SOURCE HI and output LO to SOURCE LO.
3. Using Table 603-2, sequentially apply the inputs shown, manually selecting the range after the first reading. The instrument must read within the limits specified.

Table 603-2. Performance Test

Range	DC Input	Reading	
		Low (exp.)	High (exp.)
100 uA	10 uA	9.987 (−6)	10.013 (−6)
100 uA	100 uA	99.960 (−6)	100.040 (−6)
100 uA	250 uA	249.915 (−6)	250.085 (−6)
1 mA	0.1 mA	0.09987 (−3)	0.10013 (−3)
1 mA	1.0 mA	0.99960 (−3)	1.00040 (−3)
1 mA	2.0 mA	1.99930 (−3)	2.00070 (−3)
10 mA	1.0 mA	0.9996 (−3)	1.0004 (−3)
10 mA	10 mA	9.9960 (−3)	10.0040 (−3)
10 mA	15 mA	14.9945 (−3)	15.0055 (−3)
100 mA	10 mA	9.930 (−3)	10.070 (−3)
100 mA	100 mA	99.930 (−3)	100.070 (−3)
100 mA	150 mA	149.905 (−3)	150.095 (−3)
1A	0.1A	0.09975	0.10025
1A	1A	0.99930	1.00070

603-20. Calibration

603-21. Before calibrating any part of the instrument, the Calibration Memory module should be removed if installed. Apply power and allow a two hour warm-up period. All adjustments are on the Current Shunts module. DC calibration should be performed before calibrating current. Use the following procedure to calibrate the Current Shunts module.

1. Verify that the instrument is in the 1A range and the Cal mode (CAL indicator illuminated).
2. Connect the test DVM HI input lead to TP3 and the LO input to TP1.
3. The test DVM must read less than 200 mV.
4. Remove the test DVM.
5. Select the 100 mA range on the instrument.
6. Adjust R17 for a reading between -0.000-1 and +0.000-1 (0.000 ± 1 cal digit).
7. Set the current source controls for an output of 20.0000V dc.
8. Connect the instrument HI input to the current source HI output inserting a 200 kΩ ± 0.01% resistor in series with the instrument HI input lead. Connect the LO input terminal to the current source LO output.
9. Select the 100 μA range on the instrument and adjust R31 for a reading between +99.999 and +100.001.
10. Disconnect the instrument HI input lead from the current source, remove the inserted resistor and reconnect the HI input lead.
11. Select a current source output of +1.00000 mA.
12. Adjust R34 for a reading between +0.99999-0 and +1.00001-0.

13. Select a current source output of 10.0000 mA.

14. Adjust R37 for a reading between +9.9999-0 and +10.0001-0.

15. Select a current source output of 100.000 mA.

16. Adjust R71 for a reading between +99.999-0 and +100.001-0.

17. Select a current source output of 1.00000A.

18. Adjust R68 for a reading between +0.99999-0 and +1.00001-0.

19. Select the VDC function and Autorange on the instrument.

20. Select a 50V dc output from the current source.

21. Select the ADC function on the instrument.

22. ERROR 4 is displayed to show excessive voltage in the current function.

603-22. Troubleshooting.

603-23. Troubleshooting procedures for the Current Shunts module follow the format used for the mainframe instrument. Table 603-3 assures that the problem is in the Current Shunts module. Figure 603-2, Symptom Analysis, lists symptoms and possible failures in the order of probability. Table 603-4 contains address and data information used to set up the module.

603-24. Always remove power before removing or installing modules.

603-25. PARTS LIST

603-26. Table 603-5 is a parts breakdown for the Current Shunts module. Refer to Section 5 of this manual for ordering and use code information.

Table 603-3. Current Shunts Isolation

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Perform DC Volts test (Section 4). Is DC within tolerance?	2	Section 4
2	Perform Current test. Is Current within tolerance?		3
3	Remove all optional modules except Isolator and Current Shunts. Is Current now within tolerance?	4	5
4	Replace modules one at a time, testing Current between modules. Last one in when Current goes bad is faulty. Go to appropriate subsection of Section 6.		
5	Remove Isolator. Install Interconnect/Monitor pcb. Is Current within tolerance?	6	7
6	Bad Isolator. Go to subsection 608.		
7	Bad Current Shunts module. Go to figure 603-2.		

SYMPTOM	POSSIBLE FAILURE
Zero noisy or out of tolerance	Q21, Q20, Q29, U1, Q3, Q4, leaky output FETS
No zero reading	K3, K4, Q19, U1, Q1, Q2
Always zero	K3 or Q11 open
100µA, 1 mA, 10 mA ranges bad, others OK	K4 open, Q29, Q20, leaky protection diodes
100 mA, 1 A ranges bad, others OK	Q20, Q29, leaky protection diodes, Q12
High random — full-scale readings	Q19, U1, Q1, Q2
No display	U5, U2
No ACK — Error 9 or Error 4	Voltage limit circuit, U6 or leaky diode (CR14, CR15), U5, Q18
Only 100 µA range bad	Q30, Q31, Digital Control
Only 1 mA range bad	Q7, Q10, Digital Control
Only 10 mA range bad	Q8, Q9, Digital Control
Only 100 mA range bad	K2, Q32, Digital Control
Only 1 A range bad	K2, Q28, Digital Control

Q19 DC Readings with Zero Input

Drains (10Ω resistors) ≃ –0.6 V dc
Sources (40 KΩ resistors) ≃ 8.0 V dc
U1 pin 6 ≃ 0V dc

Differences between ADC and AAC

1. AC/DC Reference (ground)
2. Frequency response in AAC
3. RT1 outputs are applied to DC Signal Conditioner for DC and to optional AC module for AC (DC Signal Conditioner bypassed)

If Q19, R15, R16, R55, or R56 are replaced, it is necessary to return the module to the factory (attn: PARTS) for temperature compensation.

Figure 603-2. Symptom Analysis

Table 603-4. Address and Data Field

Address — IC0, 1, 3 High						
	ID0	ID1	ID2	ID3	ID4	ID5
Current LO Input (K3) and Output FET (Q11)	X	X	X	0	X	X
DC Reference (Q3)	0	X	X	0	X	X
AC Reference (Q4)	1	X	X	0	X	X
100µA Range	X	1	1	0	1	1
1 mA Range	X	1	1	0	0	1
10 mA Range	X	1	1	0	1	0
100 mA Range	X	1	0	0	1	1
1A Range	X	0	1	0	1	1
Voltage Check	0	0	0	0	0	0
Reset	1	1	1	1	1	1

Table 603-5. Current Shunts Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
-03	⊘ CURRENT SHUNTS PCB ASSEMBLY FIGURE 603-3 (MIS-4104T)	ORDER	BY	OPTION -03			
C1, C2	CAP, TA, 0.47 UF +/-20%, 35V	161349	56349	196D474X0035HA1	2		
C3	CAP, MICA, 47 PF +/-1%, 500V	284802	72136	DM15E470F	1		
C4	CAP, MICA, 150 PF +/-5%, 500V	148478	72136	DM15F151J	1		
C5, C6	CAP, MICA, 100 PF +/-5%, 500V	148494	72136	DM15F101J	2		
C7	CAP, CER, 1200 PF +/-20%, 100V	358283	80031	2222-630-01-122	1		
C8, C9	CAP, MICA, 39 PF +/-5%, 500V	148544	72136	DM15E390J	2		
C10	CAP, TA, 4.7 UF +/-20%, 25V	161943	56289	196D475X0025KA1	1		
C11	CAP, TA, 220 UF +/-20%, 6V	408682	56289	196D227X0006TE4	1		
C12, C13	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	2		
C14	CAP, MICA, 390 PF +/-5%, 500V	148437	72136	DM15F391J	1		
C15-C17	CAP, TA, 10 UF +/-20%, 15V	193623	56289	196D106X0015A1	3		
CR1-CR4	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	14	4	
CR5-CR10	DIODE, SI	680447	14552	MT2061A	6	2	
CR11	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR12	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR14	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR15	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR16	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR17	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR18	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR19	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR20	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR21	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR22	DIODE, ZENER	325803	07910	TD333408	1	1	
H1	SCREW, PHP, 4-40 X 3/8	256164	89536	256164	1		
K1	RELAY ASSY						
	COIL, REED RELAY	269019	71707	U-6-P	5		
	SWITCH, DRY REED	602714	15636	V1101	5		
K2	RELAY ASSY						
	COIL, REED RELAY	269019	71707	U-6-P	REF		
K3	RELAY ASSY						
	COIL REED RELAY	269019	71707	U-6-P	REF		
K4	RELAY ASSY						
	COIL, REED RELAY	269019	71707	U-6-P	REF		
K5	RELAY ASSY						
	COIL, REED RELAY	269019	71707	U-6-P	REF		
MP1	CASE ASSEMBLY	459008	89536	459008	1		1
MP2	CASE HALF, MODULE	402990	89536	402990	REF		
MP3	CASE HALF, MODULE	402990	89536	402990	REF		
MP4	COVER, MODULE, CASE	402974	89536	402974	REF		
MP5	SHIELD, COVER	412015	89536	412015	REF		
MP6	DECAL, CURRENT SHUNTS ASSY	413419	89536	413419	REF		
MP7	DECAL, CAUTION	454504	89536	454504	REF		
MP8	GUARD, REAR	383364	89536	383364	REF		
MP9	GUARD, FRONT	383356	89536	383356	REF		
MP10	SOCKET, COMP. LEAD (not shown)	343285	27264	02-09-2133	10		

Table 603-5. Current Shunts Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
MP11	SPACER, COMPONENT (not shown)	296319	32559	T0806	10		
MP12	SPRING, COIL (not shown)	424465	83553	C0120-014-0380	1		
MP13	SPACER, STANDOFF (not shown)	335604	89536	335604	1		
Q1	XSTR, SI, NPN	218396	04713	2N3904	13	3	
Q2	XSTR, SI, PNP	195974	04713	2N3906	3	1	
Q3	DIODE, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
Q3, Q4	XSTR, FET, N-CHANNEL	261578	89536	261578	13	3	
Q5, Q6	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q7-Q10	XSTR, FET, N-CHANNEL	261578	89536	261578	REF		
Q11	XSTR, FET, N-CHANNEL	393314	89536	393314	1	1	
Q12	XSTR, FET, N-CHANNEL	261578	89536	261578	REF		
Q13-Q16	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q17	XSTR, SI, PNP	195974	04713	2N3906	REF		
Q18	XSTR, SI, PNP	226290	04713	MPS3640	1	1	
Q19	XSTR, FET, DUAL, N-CHANNEL (SELECTED)	267963	89536	267963	1	1	
Q20	XSTR, FET, N-CHANNEL	261578	89536	261578	REF		
Q21-Q23	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q25-Q27	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q28-Q32	XSTR, FET, N-CHANNEL	261578	89536	261578	REF		
Q33	XSTR, SI, PNP	195974	04713	2N3906	REF		
R1	RES, WW, 0.1 +/-0.05%, 1/2W	374611	89536	374611	1		
R2	RES, WW, 0.7 +/-0.1%, 1/4W	440404	89536	440404	1		
R3	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	23		
R4	RES, MTL. FILM, 10 +/-1%, 1/8W	268789	91637	MFF1-8A100F	4		
R5	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R6	RES, MTL. FILM, 383 +/-1%, 1/8W	375899	91637	MFF1-88380F	1		
R7	RES, WW, 419 +/-0.1%, 2W	440883	89536	440883	1		
R8	RES, MTL. FILM, 7.87K +/-1%, 1/8W	294934	91637	MFF1-87871F	1		
R9-R14	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R15, R16	RES, WW, 40K +/-0.1%	271403	89536	271403	2		
R17	RES, VAR, CERMET, 10 +/-20%, 1/2W	344135	75378	190PC100B	1		
R18	RES, MTL. FILM, 19.1K +/-1%, 1/8W	234963	91637	MFF1-81912F	1		
R19	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	2		
R20	RES, DEP. CAR, 18K +/-5%, 1/4W	348862	80031	CR251-4-5P18K	2		
R21	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R22	RES, DEP. CAR, 18K +/-5%, 1/4W	348862	80031	CR251-4-5P18K	REF		
R23, R24	RES, DEP. CAR, 39 +/-5%, 1/4W	340836	80031	CR251-4-5P39E	2		
R25-R29	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R30	RES, WW, 7975	440909	89536	440909	2		
R31	RES, VAR, CERMET, 50 +/-20%, 1/2W	267815	75378	190PC500B	1		
R32	RES, WW, 1020 +/-0.05%, 0.2W	440891	89536	440891	1		
R33	RES, MTL. FILM, 47.5K +/-1%, 1/8W	289546	91637	MFF1-84752F	1		
R34	RES, VAR, CERMET, 10K +/-20%, 1/2W	267880	75378	190PC103B	1		
R35	RES, WW, 128 +/-0.05%, 0.2W	440875	89536	440875	1		
R36	RES, MTL. FILM, 4.99K +/-1%, 1/8W	168252	91637	MFF1-84991	1		
R37	RES, VAR, CERMET, 1K +/-20%, 1/2W	267856	75378	190PC102B	1		
R38	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	1		

Table 603-5. Current Shunts Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
R39	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	5		
R40	RES, MTL. FILM, 49.9K +/-1%, 1/8W	268821	91637	MFF1-84992F	1		
R41, R42	RES, MTL. FILM, 100K +/-0.5%, 1/8W	291054	91637	MFF1-81003D	2		
R43	RES, COMP, 10M +/-10%, 1/2W	108142	01121	EB1061	2		
R44	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R45	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K	1		
R46, R47	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R48	RES, MTL. FILM, 150K +/-1%, 1/8W	241083	91637	MFF1-81503F	1		
R49-R52	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	REF		
R53	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R54	RES, MTL. FILM, 13K +/-1%, 1/8W	335539	91637	MFF1-81302F	1		
R55	RES, SELECTED				2		2
R56	RES, SELECTED				REF		
R57-R59	RES, MTL. FILM, 10 +/-1%, 1/8W	268789	91637	MFF1-8A100F	REF		
R60	RES, DEP. CAR, 5.6K +/-5%, 1/4W	442350	80031	CR251-4-5P5K6	1		
R61	RES, COMP, 10M +/-10%, 1/2W	108142	01121	EB1061	REF		
R62-R65	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R66	RES, WW, 7975	440909	89536	440909	REF		
R67	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R68	RES, VAR, CERMET, 5K +/-20%, 1/2W	267872	75378	190PC502B	2	1	
R69	RES, MTL. FILM, 12.4K +/-1%, 1/8W	261644	91637	MFF1-81242F	1		
R70	RES, MTL. FILM, 13.3K +/-1%, 1/8W	296566	91637	MFF1-81332F	1		
R71	RES, VAR, CERMET, 5K +/-20%, 1/2W	267872	75378	190PC502B	REF		
R72	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	REF		
R73	RES, MTL. FILM, 100 +/-1%, 1/8W	168195	91637	MFF1-81000F	1		
R74	RES, DEP. CAR, 6.8K +/-5%, 1/4W	368761	80031	CR251-4-5P6K8	1		
TP1-TP3	TERMINAL, TURRET	179283	88245	2010B-6	3		
U1	IC, LIN, OP AMP	483495	12040	LM318H	1	1	
U2	⊘ IC, C-MOS, HEX "D" FLIP FLOP	404509	12040	MM74C174N	1	1	
U3	⊘ IC, C-MOS, HEX, INVERTER/BUFFER	381848	02735	CD4049AE	1	1	
U4	IC, TTL, HEX INVERTER, BUFFER/DRIVER	327775	01295	SN7416J	1	1	
U5	⊘ IC, C-MOS, TRIPLE, 3-INPUT NAND GATES	375147	02735	CD4023AE	1	1	
U6	IC, LIN, OP AMP, DUAL	418566	12040	LM358N	1	1	
U7	⊘ IC, C-MOS, QUAD, 2-INPUT NOR GATES	355172	02735	CD4001AE	1	1	

1 ORDER P/N 459088 FOR COMPLETE MODULE CASE ASSY., WITHOUT PCB ASSY.

2 RESISTORS ARE TEMPERATURE COMPENSATED AND MUST BE RETURNED FOR RESELECTION IF ANY REQUIRE REPLACEMENT. (R55 AND R56)

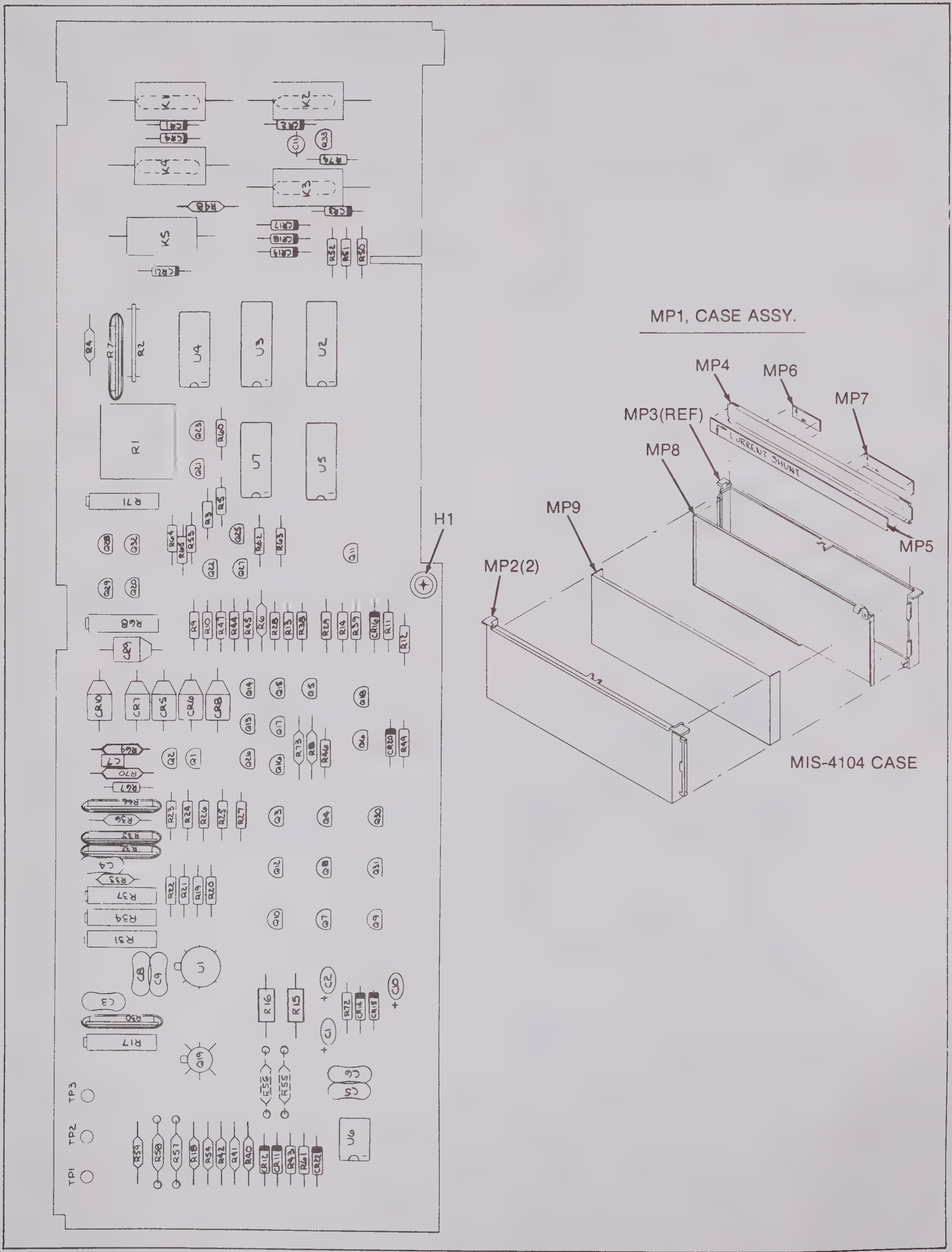
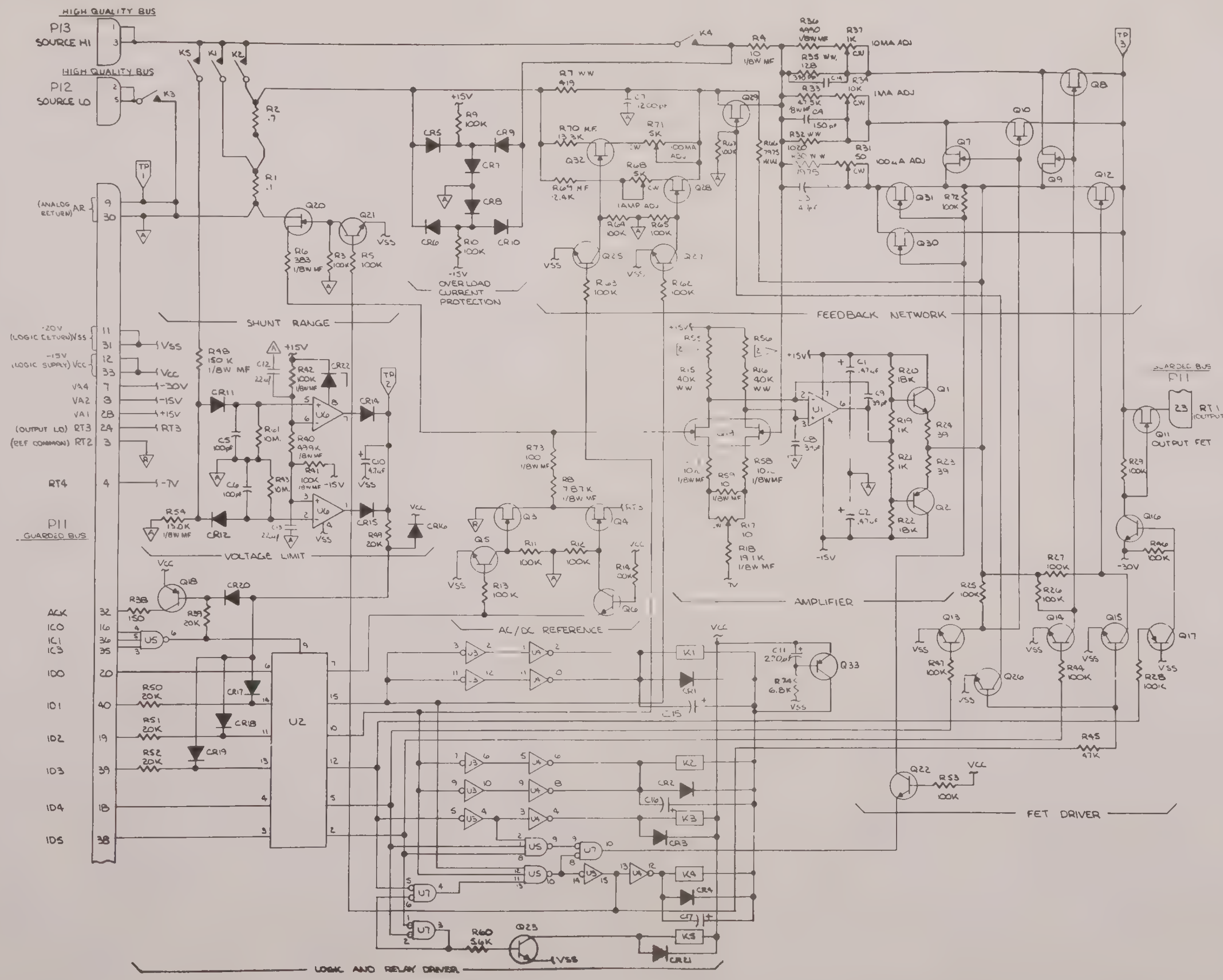

MP1, CASE ASSY.
MP4
MP6
MP7
MP3(REF)
MP8
CURRENT SHUNT
MP9
H1
MP2(2)
MP5
MIS-4104 CASE
K1
K2
K3
K4
K5
U1
U2
U3
U4
U5
U6
U7
R1
R2
R4
R7
TP1
TP2
TP3

Figure 603-3. Current Shunts Assembly


HIGH QUALITY BUS
P13
SOURCE HI
HIGH QUALITY BUS
P12
SOURCE LO
K1
K2
K3
K4
K5
R2 .7
R1 .1
TP 1
(ANALOG RETURN) AR
P11
GUARDED BUS
Q20
Q21
R16 383 1/8W MF
R3 100K
R5 100K
SHUNT RANGE
+15V
R9 100K
CR5
CR6
CR7
CR8
CR9
CR10
R10 100K
-15V
OVERLOAD CURRENT PROTECTION
R7 WW 4.19
R70 MF 13.3K
R71 5K
100MA ADJ
Q32
Q29
Q28
R68 5K
1AMP ADJ
R69 MF 2.4K
R64 100K
R65 100K
Q25
Q27
R63 100K
R62 100K
R4 10 1/8W MF
R36 4990 1/8W MF
R37 1K
10MA ADJ
R35 WW 12.8
R33 47.5K
R34 10K
1MA ADJ
R32 WW 1020
R31 50
100µA ADJ
R66 7975 WW
TP 3
Q8
Q10
Q7
Q9
Q12
Q31
Q30
R72 100K
FEEDBACK NETWORK
-20V (LOGIC RETURN) VSS
-15V (LOGIC SUPPLY) VCC
VA4 -30V
VA2 -15V
VA1 +15V
(OUTPUT LO) RT3
(REF COMMON) RT2
RT4 -7V
R48 150K 1/8W MF
CR11
CR12
C5 100pf
C6 100pf
R61 10M
R43 10M
R42 100K
R40 499K
R41 100K
CR22
U6
CR14
CR15
C10 4.7µf
TP 2
R54 15.0K 1/8W MF
R49 20K
CR16
VOLTAGE LIMIT
R73 100 1/8W MF
R8 787K 1/8W MF
Q3
Q4
Q5
Q6
R11 100K
R12 100K
R13 100K
R14 100K
AC/DC REFERENCE
R55
R56
R15 40K WW
R16 40K WW
Q19
R57 10K 1/8W MF
R59 10
R58 10K 1/8W MF
R17 10
R18 19.1K 1/8W MF
U1
C1 .47µf
C2 .47µf
C8
C9
R20 18K
R19 1K
R21 1K
R22 18K
R24 39
R23 39
Q1
Q2
-15V
AMPLIFIER
GUARDED BUS
P11
RT1 (OUTPUT +)
Q11 OUTPUT FET
R29 100K
Q16
R46 100K
-30V
R27 100K
R25 100K
R26 100K
Q13
Q14
Q15
Q17
R47 100K
R44 100K
R28 100K
Q26
R45 47K
Q22
R53 100K
FET DRIVER
Q18
R38 150
R39 20K
CR20
ACK
IC0
IC1
IC3
ID0
ID1
ID2
ID3
ID4
ID5
R50 20K
R51 20K
R52 20K
CR17
CR18
CR19
U2
U3
U4
U5
U7
C11 220µf
R34 6.8K
Q33
C15
C16
C17
CR1
CR2
CR3
CR4
CR21
Q23
R60 5.6K
LOGIC AND RELAY DRIVER

NOTES UNLESS OTHERWISE SPECIFIED

1. ALL RESISTANCE IS IN OHMS AND ALL RESISTORS 1/4W C.C..

△2 SELECT AT TEST

3 IF Q19, R15, R16, R55 OR R56 ARE REPLACED IT BECOMES NECESSARY TO T.C. THE MODULE PER MIS-4104-161 TES PROCEDURE.

IC NO	TYPE	VSS	VCC
U1	LM318	—	—
U2	74C174	8	16 1
U3	4049	8	1
U4	7416	7	14
U5	4023	7	14
U6	LM358	—	—
U7	4001	7	14 13 12

MIS 1104

Figure 603-3. Current Shunts Assembly (cont)

Option -05
IEEE-488 Interface

605-1. INTRODUCTION

605-2. This manual will specifically describe the IEEE Interface (Option -05); refer to the IEEE standard for general IEEE-488 bus interface information. Descriptions unique to the IEEE Interface will be presented separately from Programming Instructions in this manual. The Systems Multimeter Programming Card provided with the DMM lists condensed programming instructions. Refer also to Fluke Application Bulletins 25 and 36, and the IEEE Standard 488-1975 Digital Interface for Programmable Instrumentation.

605-3. SPECIFICATIONS

605-4. Specifications for the IEEE 488-1975 Standard Interface, Option -05, conform to those established in the IEEE Standard Digital Interface for Programmable Instrumentation as published by the Institute of Electrical and Electronics Engineers; 345 E. 47th Street, New York, N.Y. 10017. For an explanation of the IEEE 488-1975 Standard, refer to the Standard Document.

605-5. INSTALLATION

605-6. The IEEE-488 Interface is easily installed as a module in the 8500 Series DMM. Use the following installation procedure:

1. On the DMM, press power OFF and remove the line power cord.
2. Remove the DMM's top cover.
3. The Interface module fits in the rear slot, bus connector and addresss switches facing to the rear. Slide the module vertically between the module guides, and press firmly into place.

NOTE

Make sure the leaf spring, attached to one-half of the module shield, is resting firmly over the flange of the opposite half of the module shield.

4. If installed, remove the Interconnect PCB from slot K. This slot can be identified as the only slot with connectors on the analog and digital bus lines. To remove the Interconnect PCB, grasp the board at both ends and pull up. An end-to-end rocking motion may be necessary to free the PCB from its connectors.
5. The Isolator module must be installed in slot K whenever a remote interface (Option -05, -06 or -07) is used in the DMM.

NOTE

Use Isolator -08 with the 8500A; Isolator -08A must be used with the 8502A.

6. Connect the Interface to the IEEE-488 Bus. Attach a standard 24-pin cable to the bus connector accessed through the DMM's rear panel. Standard cables, listed in Table 605-1, are available from John Fluke Mfg. Co., Inc.
7. Optionally, connect the cable shield to chassis ground. The shield, pin 12 in the connector, is accessed from the rear panel via a banana jack. Chassis ground is available at a binding post on the DMM's rear panel.

8. Set the Interface address switches (A1-A5) as required. Controls and connections accessed through the rear panel are illustrated in Figure 605-1. Refer to Table 605-2 for permissable address settings. Depressing a switch to the bottom sets the associated address bit true (true = 1). TALK address bits T1 through T5 are equal to LISTEN address bits L1 through L5.

NOTE

If the other devices in the system are listeners only, the DMM may be place in TALK ONLY mode by toggling the TALK/ADDRESSABLE switch; access to this switch is through the rear panel.

9. Replace the DMM's top cover.

10. Energize the DMM.

11. Remote can be entered by sending any character that the DMM recognizes. While in remote, only the POWER switch (local lockout on) or the POWER and LCL/RMT switches (local lockout off) remain active on the front panel.

Table 605-1. IEEE-488 Standard Cables

ORDER NUMBER	DESCRIPTION
Y8001	IEEE-488 Cable, 1 meter
Y8002	IEEE-488 Cable, 2 meters
Y8003	IEEE-488 Cable, 4 meters

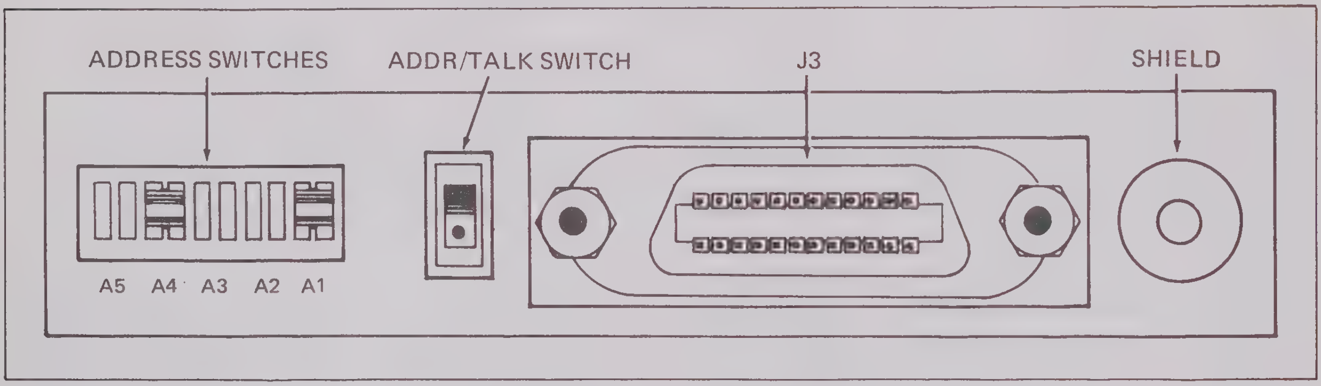


Figure 605-1. Rear Panel Access

Table 605-2. Allowable Listen and Talk Addresses

DECIMAL	5 4 3 2 1 BINARY	ASCII CHARACTER		DECIMAL	5 4 3 2 1 BINARY	ASCII CHARACTER	
		LISTEN	TALK			LISTEN	TALK
0	0 0 0 0 0	SP	@	16	1 0 0 0 0	0	P
1	0 0 0 0 1	!	A	17	1 0 0 0 1	1	Q
2	0 0 0 1 0	"	B	18	1 0 0 1 0	2	R
3	0 0 0 1 1	#	C	19	1 0 0 1 1	3	S
4	0 0 1 0 0	$	D	20	1 0 1 0 0	4	T
5	0 0 1 0 1	%	E	21	1 0 1 0 1	5	U
6	0 0 1 1 0	&	F	22	1 0 1 1 0	6	V
7	0 0 1 1 1	'	G	23	1 0 1 1 1	7	W
8	0 1 0 0 0	(	H	24	1 1 0 0 0	8	X
9	0 1 0 0 1	)	I	25	1 1 0 0 1	9	Y
10	0 1 0 1 0	*	J	26	1 1 0 1 0	:	Z
11	0 1 0 1 1	+	K	27	1 1 0 1 1	;	[
12	0 1 1 0 0	,	L	28	1 1 1 0 0	<	\
13	0 1 1 0 1	–	M	29	1 1 1 0 1	=	]
14	0 1 1 1 0	.	N	30	1 1 1 1 0	>	^
15	0 1 1 1 1	/	O				

605-7. OPERATING FEATURES

605-8. Attached to the assembly and accessible through a port on the rear panel (Figure 605-1) are a standard specified connector, five address switches and a Talk Only Mode switch. The connector is standard for the IEEE bus and is specified by the standard document. The address of the instrument is set using the five address switches. The characters used to address the instrument in the talk and listen mode are given in Table 605-1. The five low order bits of the message determine the address, the next two higher bits differentiate between the Talk and Listen modes. Normal operation allows the instrument to both talk and listen to the bus. The Listen mode can be disabled with the Talk Only switch, if desired.

605-9. OPERATING NOTES

605-10. Interface Control

605-11. Information is input to the interface from the controller on the system bus, which contains eight data lines, three handshake lines and five bus management lines. Control of the handshake and management lines is from the controller and will vary with the controller used. Refer to the instructions with the system controller for the information on how to obtain the correct level on these lines. The lines and a brief explanation of their function are given in Table 605-3. Refer to the IEEE 488-1975 Standard Manual for a further explanation of their function.

605-12. Interface Messages

605-13. Multiple line messages are input to the interface from the controller using the data lines. The messages used within the instrument are listed with their codes in Table 605-4. Further information on the messages can be obtained from the IEEE 488-1975 Standard Manual.

605-14. Status Request Responses

605-15. If enabled by the applicable Interface Interrupt Enable Code, a service request (SRQ) can be generated within the interface by either an error or ready condition. When the instrument is addressed during a serial poll operation by the IEEE 488 Controller, and an interrupt is generated, the response byte will be a zero for ready or the numeric of the applicable Error Code. If the SRQ was not generated, the response is a null character (binary 000000000) to the controller.

605-16. THEORY OF OPERATION

605-17. The IEEE Interface provides for communication between the IEEE system bus and the DMM internal bus structure. The IEEE system bus is defined by the IEEE standard; the DMM internal bus structure is discussed in the instrument Instruction Manual. System bus signal lines will be referred to by their mnemonic designators (refer to Table 605-3 for definitions).

605-18. The IEEE Interface consists of two interconnected pcb's in one module. Each pcb will have its own reference designator system. To distinguish between the two, reference designators mounted on the Piggyback board will be followed by a (PB).

605-19. Data Lines

605-20. System bus data lines (DI01-08) are applied to the interface through receiver/drivers, U21 and U24. The receivers consist of noninverting buffers, while the drivers are gates with a common enable line from U32-8.

NOTE

True conditions on the system data bus are defined as a low; true conditions on the instrument bus are defined as a high.

Outputs from the data line receiver drivers are applied directly to address decoders, U19 and U12, through address switch S1 to address decoders U6 and U3, and through inverters to a data register consisting of U30 and part of U31.

605-21. The internal DMM data bus is applied to a response register consisting of U26 and U29. This register latches data up for application to the system bus lines (the system bus requires that data be held longer than is desirable to tie up the instrument controller). Instrument data is also applied to the control register on the Piggyback board (U11-PB, U16-PB, U14-PB).

605-22. Addresses

605-23. Instrument address lines (IC0-IC6) are applied to address decoders located on the Piggyback board. All of the following listed addresses cause an ACK to be returned to the instrument controller through U6 (PB)-1.

1. IC 1, 5 and 4 High: Decoded U12 (PB)-6 to enable the response register.
2. IC 6, 4 and 3 High: U12(PB)-10 to clock data into the control register; if ID0 is high, this address also causes a Return to Local signal from U8(PB)-3.
3. IC 5, 3 and 0 High: Decoded by U13(PB)-6 to cause a software reset through U8(PB)-10.
4. IC 6, 0 and 4 High: Decoded by U13(PB)-9 to enable the status register (U28 and part of U31).
5. IC, 6, 1 and 4 High: Decoded by U13(PB)-10 to enable the data register (U30 and part of U31).

605-24. Addresses to the IEEE Interface from the system are received on the data lines when ATN is true. Address switch S1 routes My Listen Address (MLA) and My Talk Address (MTA). Decoding for MLA is done by U6-13; the DAV signal clocks this address into U11-1. The MTA flip-flop U11-1 is cleared by the UNL (Unlisten) signal (decoded by U19-13). The Message Decoder (U9, U5 and U8) is enabled by the ATN and U12-10 (decoded by DI02, DI06, DI07).

Table 605-3. Mnemonics

PIN	MNEMONICS	FUNCTION	COMMENTS
1	DIO 1	Data	Data input/output lines. Message bytes are carried on the DIO lines in a bit-parallel byte-serial form, asynchronously, and generally in a bidirectional manner.
2	DIO 2	Data	
3	DIO 3	Data	
4	DIO 4	Data	
13	DIO 5	Data	
14	DIO 6	Data	
15	DIO 7	Data	
16	DIO 8	Data	
5	EOI	End Or Identify	Used to indicate the end of a nultiple byte message.
6	DAV	Data Available	Is asserted TRUE by the sender of data when NRFD goes TRUE, remains TRUE until NDAC is sent TRUE by the data receiver.
7	NRFD	Not Ready For Data	When all devices are ready to receive data this line goes high. Remains high until DAV is sent TRUE.
8	NDAC	Not Data Accepted	When all receiving devices are through with the data on the bus, this line goes high, indicating that the sender may remove the data and set DAV low. When DAV goes to the receiving devices then pull NDAC low again.
9	IFC	Interface Clear	Sent high by the controller. It places all device interfaces in a known quiescent state.
10	SRQ	Service Request	This line is used by any device to get the attention of the controller.
11	ATN	Attention	Used by the controller to notify all other devices what type of message (interface versus device dependent) is on the data bus. When ATN is TRUE, messages sent are interface messages and all devices capable of receiving messages must handshake the transfer. When false, device dependent messages are sent and only devices that have been addressed remain active.
12		Shield*	Surrounds all conductors.
17	REN	Remote Enable	Must be TRUE to place instruments into remote. Once in Remote, if REN goes false all instruments must go to local.
18	GND	Return for DAV	
19	GND	Return for NRFD	
20	GND	Return for NDAC	
21	GND	Return for IFC	
22	GND	Return for SRQ	
23	GND	Return for ATN	
24	GND	Logic common for DIO 1-DIO 8, EOI, and REN	

**The cable shield is routed to a banana jack on the rear of the Option –05 interface adjacent to the programming conductor. This banana jack may be tied to the DMM chassis ground post located on the rear panel. However, caution must be exercised to prevent ground loops in the system.*

Table 605-4. Interface Messages

MNEMONIC	MESSAGE	CODING			ALL DEVICES RESPOND (Universal)	ADDRESSED DEVICES ONLY RESPOND	DEVICE IN LOCAL RESPONDS AND GOES TO REMOTE	NOTE
		BINARY	OCTAL	HEX				
MLA	My Listen Address	X F T A5 A4 A3 A2 A1				X	X	1
MTA	My Talk Address	X T F A5 A4 A3 A2 A1				X	X	1
UNL	Unlisten	X F T T T T T T	077	3F	X			
UNT	Untalk	X T F T T T T T	137	5F	X		X	
OTA	Other Talk Address	X X X X X X X X					X	2
SPE	Serial Poll Enable	X F F T T F F F	030	18	X		X	
SPD	Serial Poll Disable	X F F T T F F T	031	19	X		X	
LLO	Local Lockout	X F F T F F F T	021	11	X		X	
GTL	Go To Local	X F F F F F F T	001	01		X		
DCL	Device Clear	X F F T F T F F	024	14	X			
SDO	Selected Clear	X F F F F T F F	004	04		X		

605-25. Resets

605-26. Power-on or software resets may occur. At power-on, U8(PB)-10 causes an interface reset to prevent unwanted states in the interface logic. Software resets, decoded by U13(PB)-6, may occur as a result of a momentary power interruption, a front panel request, or a system request.

605-27. Control Register

605-28. The following six "D" flip-flops compose the control register:

1. Interrupt enable U14(PB)-2 remains true, except during the power-on routine.

2. A service request (SRQ) to the system controller is initiated by U14(PB)-13.

3. The instrument controller being ready for data (RFD) is indicated by U16(PB)-1.

4. At the last data byte of a message to the system from the instrument controller, U11(PB)-13 goes true.

5. Data accepted (DAC) is sent and RFD is reset by U16(PB-13.

6. When the instrument is a talker, U11(PB)-2 is used to generate the data available (DAV) signal.

605-29. Status Register

605-30. The status register consists of U28 and part of U31. The instrument address decoded by U13(PB)-9 enables a status byte to be placed on the data bus (ID0-ID7). This status byte is defined as follows:

1. ID0: true from U28-7 when in the talk only mode.

2. ID1: true from U28-9 when remote enable (REN) from the system controller is false.

3. ID2: true from U28-9 when go to local (GTL) is true from the message decoder U5-4.

4. ID3: true from U28-3 for an interface message.

5. ID4: true from U31-3 for an interface message.

6. ID5: true from U31-5 to indicate a device dependent message.

7. ID6: true from U31-7 during the serial poll mode when the system controller is requesting status.

8. ID7: true from U31-9 when the system controller is requesting data from the instrument.

605-31. Message Decoder

605-32. Interface messages sent by the system controller on the data bus are decoded by U9, U5 and U8. The device dependent messages GET, SCD and GTL require the interface to be a listener before the instrument controller is interrupted. For group execute trigger (GET), U8-11 is true. For selected device clear (SDC), U8-10 is true. For go to local (GTL), U5-4 is true. The universal messages DCL and LLO are unique in that they cause the instrument controller to be interrupted when in local. For local lockout (LLO), U5-3 is true. For device clear (DCL), U5-10 is true. In addition, U8-4 goes true for the serial poll mode (SPE), and U8-3 is true for serial poll disable (SPD).

605-33. Mode Register

605-34. The mode register consists of the following four J-K flip-flops: U11-1 (clocks in MLA), U11-15 (clocks in MTA), U15-1 (true in remote mode) and U15-15 (true in serial poll mode).

605-35. Instrument Interrupts

605-36. Except during the power-on routine, interrupts are enabled by U14(PB)-2. The interrupt flip-flop may be clocked by the DAV signal through U4(PB)-4 and U4(PB)-3 or by U6(PB)-13 when the instrument is to be an active talker.

605-37. MAINTENANCE

605-38. Refer to Section 4 of the Instruction Manual for information on cleaning the module. The two pcb's are disassembled by removing the screws and standoffs fastening them together. To prevent damage to the electrical connectors, pull the boards straight apart.

605-39. PERFORMANCE TEST

605-40. Operation of the IEEE Interface can be verified by programming changes in range, output and mode, and by observing response data.

605-41. CALIBRATION

605-42. The IEEE Interface does not require calibration.

605-43. TROUBLESHOOTING

605-44. Troubleshooting the -05 IEEE Remote Interface Option consists of the tabular flow chart in Table 605-5. When a step in the flow chart is completed, check for a decision transfer, If no decision is required, perform the next step of the table in sequence.

605-45. Programming Instructions

605-46. Programming commands and instrument responses are explained in Table 605-6. For the 8505A and 8506A, refer to Section 2A.

605-47. PARTS LIST

605-48. Table 605-6 provides a detailed parts list for the Interface PCB; Table 605-7 lists parts for the Piggyback PCB. Refer to Section 5 of this manual for ordering information.

Table 605-5. Troubleshooting

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
	NOTE *Due to the speed and complexity of the data on the bus system, it is recommeded that the pcb be sent to the nearest Fluke Service Center for repair when a problem is isolated to the interface. The following table will be of some assistance when troubleshooting simpler problems; however, manu many problems will require the use of a Fluke Trendar, or similar logic board tester. The instrument must be connected through a bus network to a system controller, e.g., the Tektronix 4051 or HP 9825, to operate.*		
1	This test is based on the assumption that the DMM was checked and found opeational in local operation prior to installation of the IEEE Interface.		
2	Install the IEEE Interface Assembly in the instrument and apply power from the front panel switch.		
3	Is the front panel display correct?	6	4
4	If the display is blank, check the ACK circuit on the PB PCB.		
5	If the display is incorrect, check the input latches and output buffers on the Main PCB. Repair as required and return to step 2.		
6	Address the instrument on the IEEE bus with the applicable address. Does the instrument go into remote?	8	7
7	On the Main Board check the address lines through the Receiver/Driver, the address switches, the MLA circuitry, and the REN and DAV signals. On the Piggyback Board check the INT circuit. Repair as required then resume at step 2.		
8	Program an instruction from the remote controller. Is the output display as programmed?	10	9
9	Check the output latches and buffers, the UNL circuitry and the Receiver/Driver on the Main Board. Repair as required and return to step 8.		
10	Does the instrument respond to and "SRQ" from an Interrupt Ready or Error?	12	11
11	Check the SRQ line inand the Receiver/Driver on the Main Board and the status latches on the Piggyback Board. Repair as required then resume at step 10.		
12	Does the interface clear from the system controller?	14	13
13	Check the IFC input and the IFC circuit. Repair as required, then resume at step 12.		
14	Can the Front Panel be locked out from the system controller?	16	15
15	Check the LLO line and the decoder circuit. Repair as required then resume at step 14.		
16	Troubleshooting of the IEEE Interface, as applicable at this level, is complete.		

Table 605-6. IEEE 488-1975 Interface PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
-05⊗	IEEE 488-1975 INTERFACE PCB ASSEMBLY FIGURE 605-2 (MIS-4172T)	ORDER	BY	OPTION -05			
	⊗IEEE 488-1975 PIGGYBACK PCB ASSEMBLY FIGURE 605-3 (MIS-4074)				1		
C1	CAP, MICA, 270 PF +/-5%, 500V	148452	72136	DM15F271J	2		
C2	CAP, MICA, 270 PF +/-5%, 500V	148452	72136	DM15F271J	REF		
C4-C8	CAP, CER, 0.22 UF +/- 20%, 50V	309849	71590	CW30C224K	5		
C9	CAP, MICA, 100 PF +/-5%, 500V	148494	72136	DM15F101J	1		
CR1	DIODE, SI, HI-SPEED SWITCH	203323	07910	1N4448	1	1	
H1	LOCKWASHER, SPLIT, 8-32	111070	89536	111070	2		
H2	SCREW, PHP, 4-40 X 3/8 (not shown)	256164	89536	256164	1		
H3	SCREW, CONN MTG, (USE ON J3)	429472	89536	429472	2		
J2	POST, CONTACT	447813	22526	65501-136	3		
J3	CONN, CABLE, 24-PIN, MODIFIED	534107	89536	534107	1		
MP1	CASE ASSY (INCLUDES MP2-MP8)	458935	89536	458935	1		1
MP2	CASE HALF, MODULE	402990	89536	402990	REF		
MP3	CASE HALF, MODULE, MODIFIED	456079	89536	456079	REF		
MP4	COVER, MODULE CASE	402974	89536	402974	REF		
MP5	SHIELD, COVER	441022	89536	441022	REF		
MP6	DECAL, IEEE INTERFACE ASSY	413518	89536	413518	REF		
MP7	DECAL, CAUTION	454504	89536	454504	REF		
MP8	GUARD, REAR	383364	89536	383364	REF		
MP9	COIL, SPRING (not shown)	424465	83553	C0120-014-0380	1		
MP10	SPACER, 4-40 X .187 (not shown)	335604	89536	335604	1		
MP11	SPACER, 4-40 X .340	380329	89536	380329	2		
MP12	SPACER, 6-32 X .550	312421	89536	312421	2		
MP13	SPACER, 6-32 X .220	261727	89536	261727	2		
Q1	XSTR, SI, NPN	218396	04713	2N3904	1	1	
R1	RES, DEP. CAR, 18K +/-5%, 1/4W	348862	80031	CR251-4-5P18K	1		
R2	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	1		
R3	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	1		
R4	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7	1		
R5	RES, DEP. CAR, 15K +/-5%, 1/4W	348854	80031	CR251-4-5P15K	1		
S1	SWITCH, MODULE SPDT, 5-POS.	417766	00779	435470-4	1	1	
S2	SWITCH, SLIDE, SPDT	417287	95146	MSS-1040-1	1	1	
U1⊗	IC, C-MOS, QUAD, 2-INPUT NAND GATE	355198	02735	CD4011AE	1	1	
U2⊗	IC, COS/MOS, DUAL, 4-INPUT, NOR GATES	363820	02735	CD4002AE	1	1	
U3⊗	IC, C-MOS, 8-INPUT, NOR GATES	408781	02735	CD4078BE	3	1	
U4⊗	IC, C-MOS, QUAD, 2-INPUT AND GATE	408401	02735	CD4081BE	2	1	
U5⊗	IC, COS/MOS, QUAD, 2-INPUT NOR GATES	355172	02735	CD4001AE	3	1	
U6⊗	IC, C-MOS, 8-INPUT, NOR GATES	408781	02735	CD4078BE	REF		
U7⊗	IC, COS/MOS, TRIPLE, 3-INPUT NOR GATES	355180	02735	CD4025AE	1	1	
U8⊗	IC, COS/MOS, QUAD, 2-INPUT, NOR GATES	355172	02735	CD4001AE	REF		
U9⊗	IC, C-MOS, DCDR/MULTIPLEXER	408369	04713	MC14556CP	1	1	
U10⊗	IC, C-MOS, QUAD, 2-INPUT OR GATE	408393	02735	CD4071BE	1	1	

Table 605-6. IEEE 488-1975 Interface PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
U11⊗	IC, COS/MOS, DUAL, JK MASTER FLIP FLOP	355230	02735	CD4027AE	2	1	
U12⊗	IC, C-MOS, TRIPLE 3-INPUT NAND GATES	375147	02735	CD4023AE	1	1	
U13⊗	IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	2	1	
U14⊗	IC, COS/MOS, QUAD, 2-INPUT NOR GATES	355172	02735	CD4001AE	REF		
U15⊗	IC, COS/MOS, DUAL, JK MASTER FLIP FLOP	355230	02735	CD4027AE	REF		
U16⊗	IC, C-MOS, QUAD, 2-INPUT, NAND	404632	02735	CD4093BE	1	1	
U17⊗	IC, C-MOS, QUAD, 2-INPUT AND GATE	408401	02735	CD4081BE	REF		
U18⊗	IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	REF		
U19⊗	IC, C-MOS, 8-INPUT, NOR GATES	408781	02735	CD4078BE	REF		
U20	IC, QUAD, INTERFACE, BUS XCVR	428649	04713	MC3446P	4	1	
U21	IC, QUAD, INTERFACE, BUS XCVR	428649	04713	MC3446P	REF		
U22⊗	IC, C-MOS, HEX INVERTER BUFFER	381848	02735	CD4049AE	2	1	
U24	IC, QUAD, INTERFACE, BUS XCVR	428649	04713	MC3446P	REF		
U25⊗	IC, C-MOS, HEX INVERTER BUFFER	381848	02735	CD4049AE	REF		
U26⊗	IC, COS/MOS, QUAD, LOCKED D LATCH	355149	02735	CD4042AE	2	1	
U27	IC, QUAD, INTERFACE, BUS XCVR	428649	04713	MC3446P	REF		
U28⊗	IC, C-MOS, TRI HEX NON INV BUFFERS	407759	12040	MM80C97N	3	1	
U29⊗	IC, COS/MOS, QUAD, LOCKED D LATCH	355149	02735	CD4042AE	REF		
U30⊗	IC, C-MOS, TRI HEX NON INV BUFFERS	407759	12040	MM80C97N	REF		
U31⊗	IC, C-MOS, TRI HEX NON INV BUFFERS	407759	12040	MM80C97N	REF		
U32	IC, TTL, QUAD, 2-INPUT NAND GATES	393033	01295	SN74LS00N	1	1	
U33	RES. NETWORK, 4.7K	412916	89536	412916	2	1	
U34	RES. NETWORK, 4.7K	412916	89536	412916	REF		

1 ORDER P/N 458935 FOR COMPLETE MODULE CASE ASSY., WITHOUT PCB ASSY.

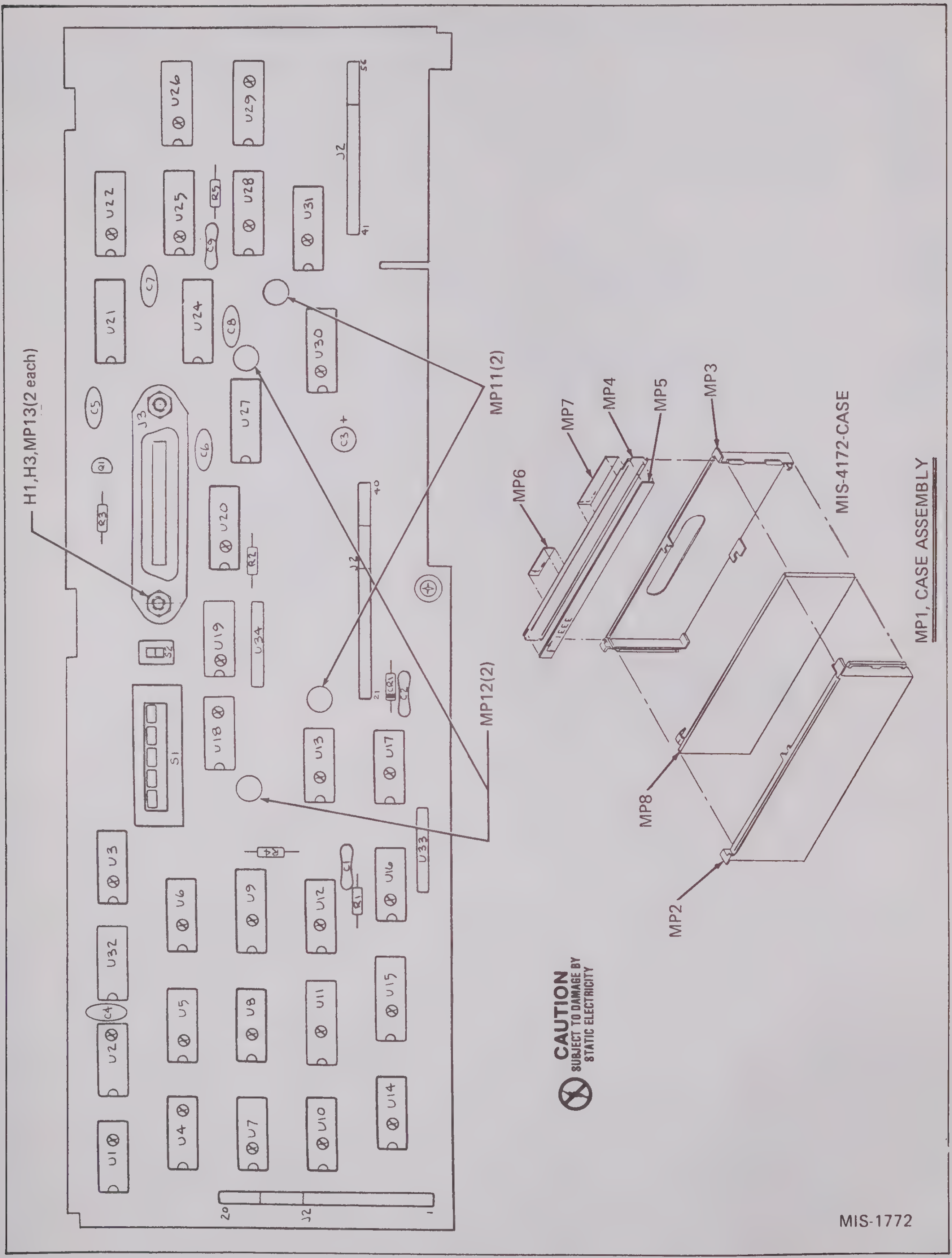
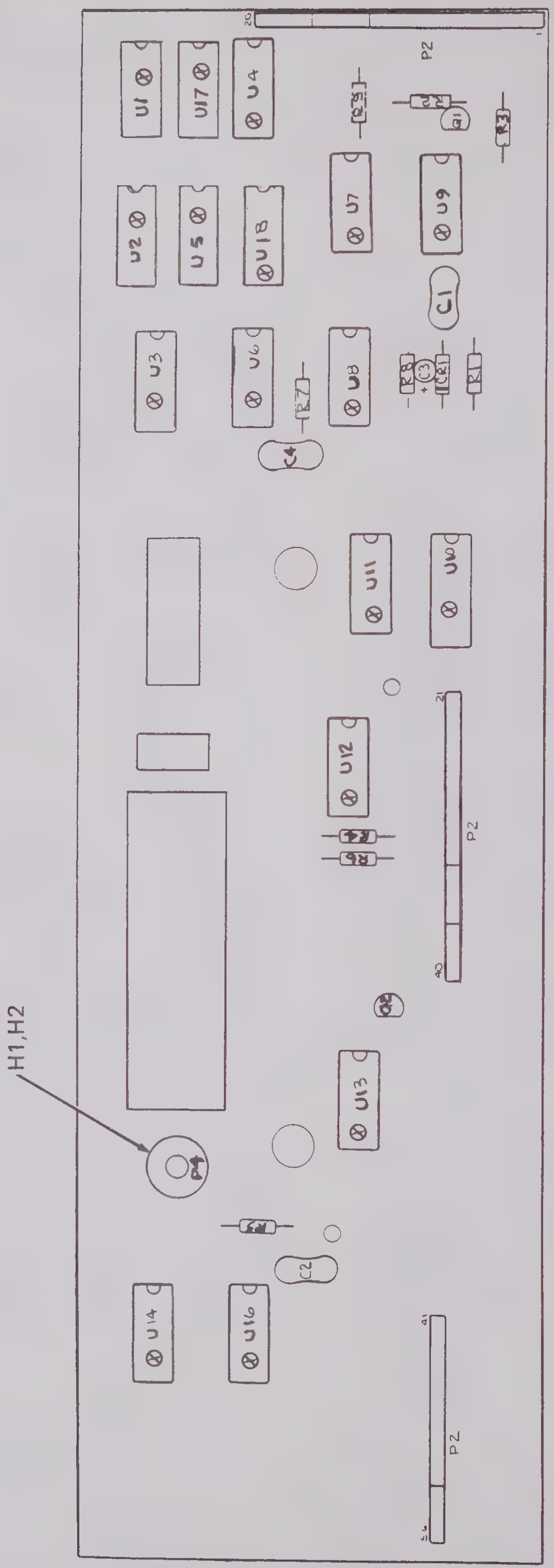

H1,H3,MP13(2 each)
MP11(2)
MP12(2)
MP6
MP7
MP4
MP5
MP3
MIS-4172-CASE
MP1, CASE ASSEMBLY
MP8
MP2
CAUTION
SUBJECT TO DAMAGE BY STATIC ELECTRICITY
MIS-1772
U1
U2
U3
U4
U5
U6
U7
U8
U9
U10
U11
U12
U13
U14
U15
U16
U17
U18
U19
U20
U21
U22
U24
U25
U26
U27
U28
U29
U30
U31
U32
U33
U34
J2
J3
S1
Q1
R1
R2
R3
R4
R5
C1
C2
C3
C4
C5
C6
C7
C8
C9
CR1
IEEE
1
20
21
40
41
56

Figure 605-2. IEEE 488-1975 Interface PCB Assembly

Table 605-7. IEEE 488-1975 Piggy Back PCB Assembly

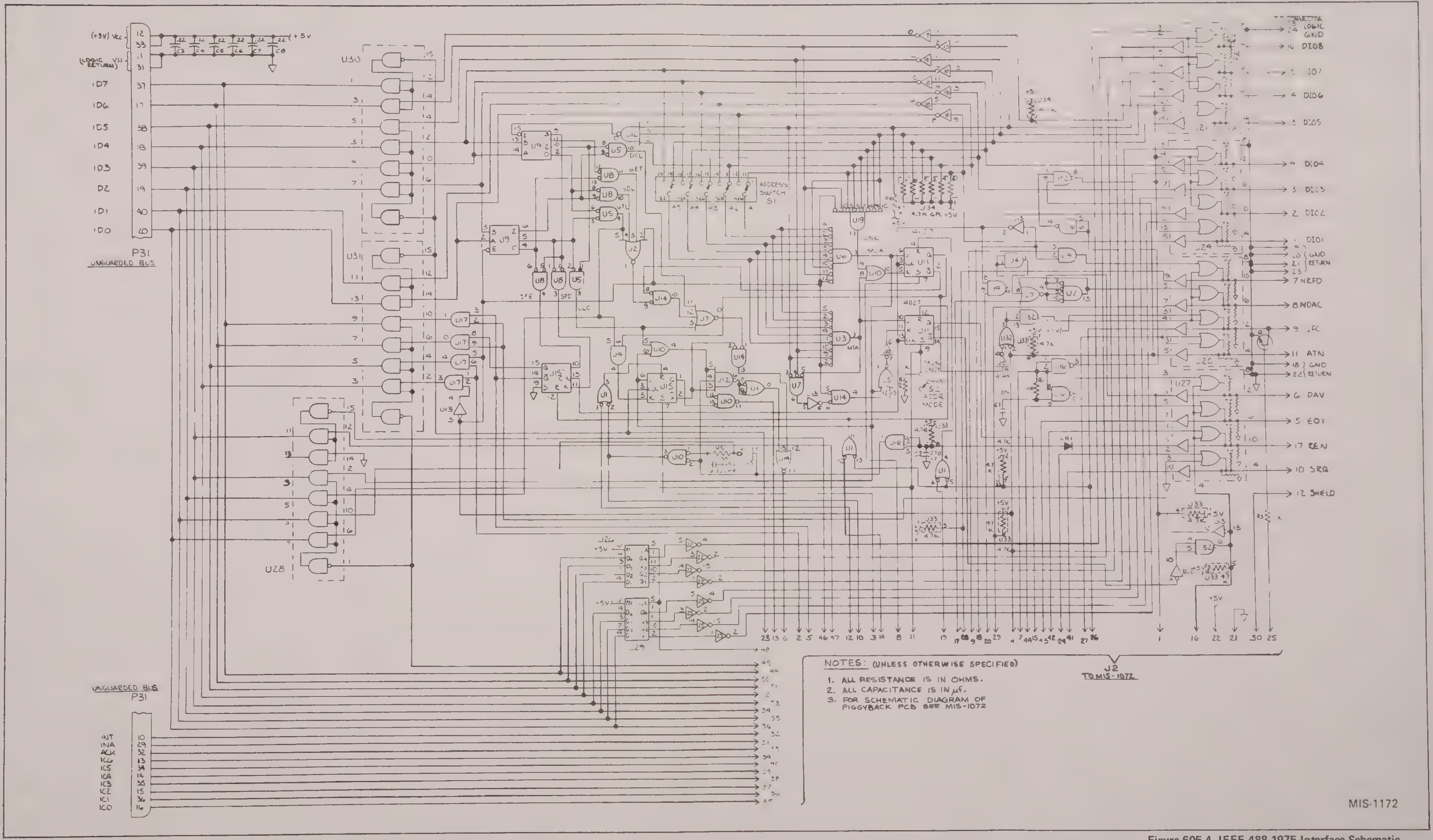
REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
-05P⊗	IEEE-488-1975 PIGGY BACK PCB ASSEMBLY FIGURE 605-3 (MIS-4074)	PART	OF	OPTION -05			
C1	CAP, MICA, 270 PF +/-5%, 500V	148452	72136	DM15F271J	2		
C2	CAP, MICA, 100 PF +/-5%, 500V	148494	72136	DM15F101J	1		
C3	CAP, TA, 1 UF +/-20%, 35V	161919	56289	196D105X0035JA1	1		
C4	CAP, MICA 270 PF +/-5%, 500V	148452	72136	DM15F271J	REF		
CR1	DIODE, HI-SPEED SWITCHING	203323	07910	1N4448	1	1	
H1	WASHER, FLAT, S/S 1/4 INCH (W/P4)	200980	86928	5710-65-16	1		
H2	WASHER, INT LOCK, 1/4 INCH (W/P4)	110817	73734	1308	1		
P2	CONNECTOR, SOCKET, 20 PIN	447110	30035	SK-109-1-20	2		
	CONNECTOR, SOCKET, 16 PIN	447102	20447	SS-109-1-16	1		
P4	BINDING POST	441741	89536	441741	1		
Q1	XSTR, SI, NPN	218396	04713	2N3904	1	1	
Q2	XSTR, SI, PNP	226290	04713	MPS3640	1	1	
R1	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	3		
R2	RES, DEP CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K	2		
R3	RES, DEP CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	2		
R4	RES, DEP CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	REF		
R5	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R6	RES, DEP CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K	REF		
R7	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R8	RES, DEP CAR, 15K +/-5%, 1/4W	348854	80031	CR251-4-5P15K	1		
R9	SELECTED AT TEST (may or may not be added)						
U1⊗	IC, C-MOS, DUAL "D" FLIP-FLOP	340117	02735	CD4013AE	5	1	
U2⊗	IC, COS/MOS, QUAD, 2-INPUT NOR GATES	355172	02735	CD4001AE	2	1	
U3⊗	IC, C-MOS, QUAD, 2-INPUT NAND GATE	404632	02735	CD4093BE	1	1	
U4⊗	IC, COS/MOS, QUAD, 2-INPUT NOR GATES	355172	02735	CD4001AE	REF		
U5⊗	IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	2	1	
U6⊗	IC, COS/MOS, DUAL, 4-INPUT NOR GATES	363820	02735	CD4002AE	1	1	
U7⊗	IC, C-MOS, HEX INVERTER	404681	02735	CD4069BE	REF		
U8⊗	IC, C-MOS, QUAD, 2-INPUT, NAND GATES	355198	02735	CD4011AE	2	1	
U9⊗	IC, C-MOS, QUAD, 2-INPUT, NAND GATES	355198	02735	CD4011AE	REF		
U10⊗	IC, C-MOS, HEX INVERTER BUFFERS	381848	02735	CD4049AE	1	1	
U11⊗	IC, C-MOS, DUAL "D" FLIP-FLOP	340117	02735	CD4013AE	REF		
U12⊗	IC, C-MOS, TRIPLE 3-INPUT AND GATES	408807	02735	CD4073BE	1	1	
U13⊗	IC, C-MOS, TRIPLE 3-INPUT NAND GATES	375147	02735	CD4023AE	1	1	
U14⊗	IC, C-MOS, DUAL "D" FLIP-FLOP	340117	02735	CD4013AE	REF		
U16⊗	IC, C-MOS, DUAL "D" FLIP-FLOP	340117	02735	CD4013AE	REF		
U17⊗	IC, C-MOS, TRIPLE 3-INPUT NOR GATES	355180	02735	CD4025AE	1	1	
U18⊗	IC, C-MOS, DUAL "D" FLIP-FLOP	340117	02735	CD4013AE	REF		


P2
20
1
U1
U17
U4
R2
R3
Q1
U2
U5
U18
U7
U9
C1
U3
U6
R7
U8
R8
C3
CR1
R1
C4
U11
U10
21
U12
R4
R6
P2
40
Q2
U13
H1,H2
P4
R5
C2
U14
U16
41
P2

CAUTION
SUBJECT TO DAMAGE BY
STATIC ELECTRICITY

MIS-1674

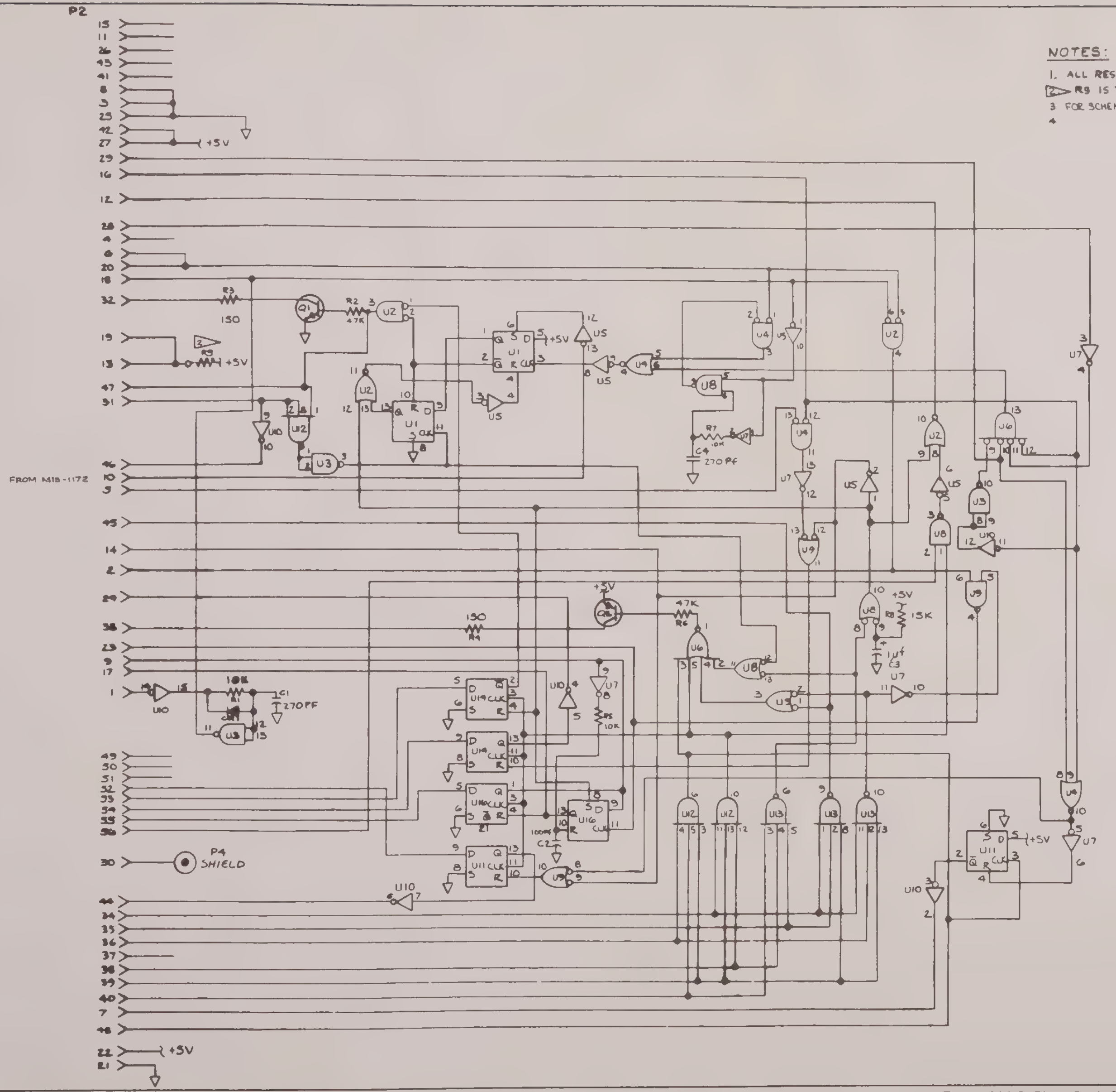
Figure 605-3. IEEE 488-1975 Piggy Back PCB Assembly


(+5V) Vcc
(LOGIC RETURN) Vss
+5V
ID7
ID6
ID5
ID4
ID3
D2
ID1
ID0
P31
UNGUARDED BUS
U30
U31
U28
U19
U5
U8
U9
U2
U14
U7
U17
U13
U15
U1
U4
U10
U12
U3
U6
U11
U16
U32
U33
U34
U26
U29
U24
U20
U27
ADDRESS SWITCH S1
S2 ADDR MODE
4.7K
+5V
CR1
LOGIC GND
DIO8
DIO7
DIO6
DIO5
DIO4
DIO3
DIO2
DIO1
GND RETURN
7 NRFD
8 NDAC
9 IFC
11 ATN
18 GND
22 RETURN
6 DAV
5 EOI
17 REN
10 SRQ
12 SHIELD
R3
UNGUARDED BUS
P31
INT
INA
ACK
IC6
IC5
IC4
IC3
IC2
IC1
IC0
J2
TO MIS-1072
MIS-1172

NOTES: (UNLESS OTHERWISE SPECIFIED)

1. ALL RESISTANCE IS IN OHMS.
2. ALL CAPACITANCE IS IN μf.
3. FOR SCHEMATIC DIAGRAM OF PIGGYBACK PCB SEE MIS-1072

Figure 605-4. IEEE 488-1975 Interface Schematic


P2
15
11
26
43
41
8
3
25
42
27
+5V
29
16
12
28
4
6
20
18
32
R3
150
Q1
R2
47K
U2
19
13
R9
+5V
47
31
U10
U12
U3
U1
S
D
Q
R
CLK
U5
U4
U8
R7
10K
C4
270 PF
U7
U9
U6
U13
FROM MIS-1172
10
9
45
14
2
24
38
23
17
1
R4
150
Q2
47K
R6
R8
15K
C3
1µf
U14
U16
U11
R1
10K
C1
270PF
R5
10K
C2
100pf
49
50
51
52
53
54
55
56
30
P4
SHIELD
44
34
35
36
37
39
40
7
48
22
21

NOTES: (UNLESS OTHERWISE SPECIFIED).

1. ALL RESISTORS ARE C.C. 1/4W AND RESISTANCE IS IN OHMS.

2▷ R9 IS TO BE SELECTED AT TEST IF REQUIRED.

3 FOR SCHEMATIC DIAGRAM OF MAIN PCB SEE MIS-1172

4

MIS-1074

Figure 605-5. Piggy Back Schematic

Option -06
Bit Serial Interface

606-1. INTRODUCTION

606-2. The Bit Serial Asynchronous Interface provides remote programming capability in applications where speed is not a critical factor. Switch selectable baud rates, stop bits, and current requirements permit maximum flexibility.

606-3. SPECIFICATIONS

606-4. The Bit Serial Asynchronous Interface meets or exceeds the requirements for data transmission and reception of EIA Standard RS-232B or C, MIL-STD-188B, CCITT V24 and 20 mA current loop. Specifications are as follows:

Input Format	Byte Serial, 8-bit parallel.
Timing Format	Asynchronous.
Output Format	Bit Serial.
Baud Rates	50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, 4800 and 9600.
Operating Power	Derived from the DMM.
Operating Temperature	0° to 50°C.

606-5. INSTALLATION

606-6. The Bit Serial Interface is easily installed as a module in the 8500 series DMM. Use the following installation procedure:

1. On the DMM, press power OFF and remove the line power cord.

2. Remove the DMM's top cover.

3. The Interface module fits in the rear slot, bus connector and address switches facing to the rear. Slide the module vertically between the module guides, and press firmly into place.

NOTE

Make sure the leaf spring, attached to one-half of the module shield, is resting firmly over the flange of the opposite half of the module shield.

4. If installed, remove the Interconnect PCB from slot K. This slot can be identified as the only slot with connectors on the analog and digital bus lines. To remove the Interconnect PCB, grasp the board at both ends, and pull up. An end-to-end rocking motion may be necessary to free the PCB from its connectors.

5. The Isolator module must be installed in slot K whenever a remote interface (Option -05, -06 or -07) is used in the DMM.

NOTE

Use Isolator -08 with the 8500A; Isolator -08A must be used with the 8502A.

6. Replace the DMM's top cover.

606-7. GENERAL

606-8. EIA Standard RS-232-C provides the electronics industry with the ground rules necessary for independent manufacturers to design and produce both data terminal and data communication equipment that conforms to a common interface requirement. As a result, a data communications system can be formed by connecting an RS-232-C data terminal (such as the 8502A) to an RS-232-C data communications peripheral (such as a TTY, MODEM, computer, etc.). This works fine on paper. However, in practice the user must be aware of the subtleties of serial binary data interchange to ensure that any two pieces of RS-232-C equipment will be compatible. For example, the two instruments must share at least one of the features from each of the following characteristics.

1. Timing Format - Synchronous or Asynchronous.
2. Transmission Mode - Simplex, half-duplex, or full duplex.
3. Baud Rate (bits per second) - 50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, 4800, 9600.
4. Bits per character - 5, 6, 7, 8.
5. Parity Bit - Odd, even, high, low, not used.
6. Data Interface Levels - EIA or 20 mA current loop.

606-9. Timing formats conforming to both synchronous and asynchronous operation are shown in Figure 617-1. In asynchronous operation each character is bracketed by both start and stop bits. These bits separate the characters and synchronize both the transmission and receipt of data. When data is not being sent the data line is held high. In synchronous operation a sync character is sent prior to each data stream (a data stream usually consists of a block of characters). When the line is idle, a fill or sync character is continuously transmitted.

606-10. Transmission mode is an overall system requirement. It defines the communication ability of both instruments in the system configuration. Simplex indicates data transmission in one direction only. Half-duplex permits two way communication, but not simultaneously. Simultaneous transmission of data in both directions defines the full duplex system. Obviously, an instrument capable of full duplex operation can be downgraded to simplex operation. However, the reverse is not possible without degrading the system capability.

606-11. Baud rate is usually selectable on the RS-232-C Interface. If it is not, the manufacturer usually offers a choice when the instrument is purchased.

606-12. Character format (bits per character and parity) is somewhat flexible between instruments. Investigate the requirement of both instruments before committing either to a system configuration.

606-13. Data interface levels can occur as either EIA voltage levels or as a 20 mA current loop. At times an interface offers both simultaneously. The 20 mA current loop is used almost exclusively for teletypewriter, or paper tape punch/reader interface. EIA voltage levels are: 1 or OFF = –15 to –3V dc, 0 or ON = +3 to +15V dc.

606-14. OPERATING FEATURES

606-15. Attached to the PCB and accessible through a port on the rear panel (Figure 606-1) are a standard specified connector and a switch module with eight micro-switches. The connector is standard for the RS-232 Interface and is specified by the standard document. The eight switches control the operating modes of the interface and the BAUD rate. The modes selected by the switches are shown in Table 606-1 and Table 606-2. The selection of Odd or Even parity with switch 8 is applicable only if the parity feature has been selected using the jumpers described below.

606-16. The interface is shipped configured for an eight bit character without parity. Selection of parity and five, six or seven bit characters can be accomplished by installing jumpers into the PCB as shown in Table 606-3.

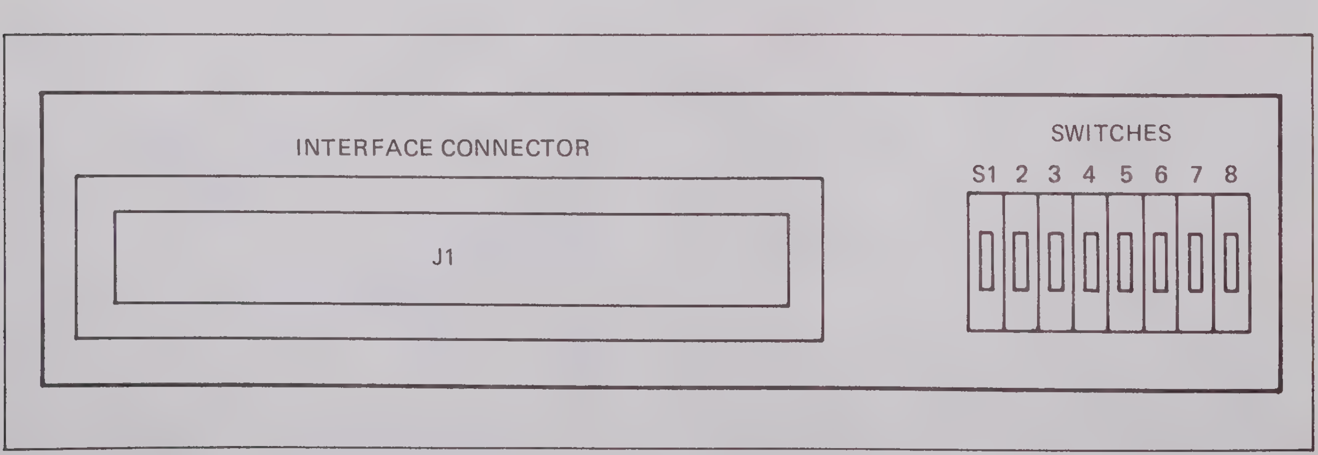


Figure 606-1. Rear Panel Access

Table 606-1. Mode Selection

SW#	SELECTION	SW ON	SW OFF
S1	Current Loop/RS232	Current	RS232
S2	RS232B/RS232C	RS232B	RS232C
S3	Stop Bits	1 Bit	2 Bits
S4	Baud Rate	*	*
S5	Baud Rate	*	*
S6	Baud Rate	*	*
S7	Baud Rate	*	*
S8	Parity	Odd	Even

* Defined in Table 606-2

Table 606-2. Baud Rate Selection

COUNT	S4	S5	S6	S7	BAUD RATE
0	OFF	OFF	OFF	OFF	110
1	OFF	OFF	OFF	ON	150
2	OFF	OFF	ON	OFF	300
3	OFF	OFF	ON	ON	2400
4	OFF	ON	OFF	OFF	1200
5	OFF	ON	OFF	ON	1800
6	OFF	ON	ON	OFF	4800
7	OFF	ON	ON	ON	9600
8	ON	OFF	OFF	OFF	2400
9	ON	OFF	OFF	ON	600
10	ON	OFF	ON	OFF	200
11	ON	OFF	ON	ON	134.5
12	ON	ON	OFF	OFF	75
13	ON	ON	OFF	ON	50

Table 606-3. Jumper Arrangements

	JUMPER #1 INSTALLED	JUMPER #2 INSTALLED	JUMPER #3 INSTALLED
Bit 5	Yes	Yes	N/A
Bit 6	No	Yes	N/A
Bit 7	Yes	No	N/A
Bit 8	No	No	N/A
Parity	N/A	N/A	Yes
No Parity	N/A	N/A	No

606-17. THEORY OF OPERATION

606-18. General

606-19. The bit serial interface alters and transmits data between the eight bit (byte) parallel format used on the instrument bus and the bit serial format of the system bus. As shown on the schematic, data inputs from either the system bus or the instrument bus are latched into universal asynchronous receiver transmitter (UART) U9, which is driven by a progammable clock (U3) set at the selected baud rate. Data in the Instrument Bus (ID0-ID7) is latched into the UART on DB1 through DB8 and output from the UART to the instrument bus on RD1 through RD8. Four separate functions are decoded from the control lines, and the receipt of any one generates a common acknowledgement signal (ACK). An interrupt function can be generated to notify the instrument controller the received data is available, allowing polled or interrupt control of the interface.

606-20. Functions

606-21. An address of IC0, IC4 and IC6 high with the remaining lines low generates the STATIN function. This generates ACK and enables the tri-state transmitters on the ID0-ID3 lines so that DA (received data available at RD1-RD8), OR (overrun; i.e., a new character received prior to final transmission of the previous character), RVMT (transmitter buffer empty and ready for the next character) and/or FE (framing error; i.e., no stop bit with received character) can be placed on the data lines.

606-22. The DATIN function (IC1, IC4, IC6 only high) strobes the RDE and RDA input to the UART. The UART is enabled to place data on the instrument bus by RDE and to receive another serial character from the system bus by RDA.

606-23. With IC2, IC4 and IC5 high, COUT is decoded to reset the UART and clock U5-3. If ID7 is high with COUT, the interrupt capability is disabled by enabling the reset at U5-10. This action prevents an interrupt signal to the instrument controller until removed. If ID8 is low, the interrupt circuitry is enabled.

606-24. DATOUT is decoded from IC3, IC4 and IC6 high, to strobe the DS input to the UART. The rising edge of DS initiates serial transmission of the character from SO onto the system bus. It is available at both J1-2 for RS-232 and J1-11 for the 20 mA current loop, for the users selection.

606-25. Interrupt

606-26. When DA (received data available) goes high, an interrupt is generated (unless it has been disabled by the COUT function) for a low at INT. The instrument controller responds with an INA, generating an ACK and enabling U8-15 to pass the output of the interrupt flip-flop to the instrument controller for interrupt vectoring. The removal of INA by the instrument controller causes the Interrupt flip-flop to reset itself and prepare the circuit for the next interrupt.

606-27. MAINTENANCE

606-28. Refer to Section 4 of the Instruction Manual for information on module disassembly and cleaning.

606-29. PERFORMANCE TEST

606-30. Operation of the Bit Serial Interface may be verified by programming changes in range, output and mode, and by observing response data.

606-31. CALIBRATION

606-32. The Bit Serial Interface does not require calibration.

606-33. TROUBLESHOOTING

606-34. Troubleshooting for the -06 Bit Serial Asynchronous Remote Interface Option consists of the tabular flow chart in Table 606-4. When a step in the flow chart is completed, check for a decision transfer. If no decision is required, perform the next step of the table in sequence.

606-35. PROGRAMMING INSTRUCTIONS

606-36. Programming commands and instrument responses are explained in Table 606-5. For the 8505A and 8506A, refer to Section 2A.

606-37. LIST OF REPLACEABLE PARTS

606-38. Table 606-5 is a list of replaceable parts for the Bit Serial Interface Option. Refer to Section 5 for an explanation of the columnar entries.

Table 606-4. Bit Serial Interface Troubleshooting

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
	NOTE *The instrument must be connected through a bus network to a system controller, e.g., the Tektronix 4051 or HP 9825, to operate.*		
1	This troubleshooting procedure is based on the assumption that the instrument has been checked in local and found to be operational in all aspects prior to installation of the Bit Serial Interface.		
2	Install the Bit Serial Interface in the instrument and apply power from the front panel switch.		
3	Is the display blank?	4	7
4	Check the address lines and address decoders.		
5	Check for a high ACK line. Repair as required and resume at step 2.		
6	If the display is incorrect (garbled or wrong), check the input ID lines and gates. Repair as required and resume at step 2.		
7	Using the controller, instruct the instrument to go to remote (program the character "J").		
8	Does the instrument go into remote?	10	9
9	Check the input gates (TP1), the UART (U9), the baud rate at TP3, the INT circuit, and the status output buffer.		
10	Program several instructions from the remote controller.		
11	Does the instrument respond correctly to the programmed instructions?	13	12
12	Check the UART (U9), the output gates (U4), and the data input gate (U7). Repair as required and resume at step 10.		
13	Troubleshooting of the Bit Serial Interface, as applicable at this level, is complete.		

Table 606-5. Bit Serial Asynchronous Interface PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
-06⊗	BIT SERIAL ASYNCHRONOUS INTERFACE ASSY FIGURE 606-3 (MIS-4170T)	ORDER	BY	OPTION -06			
C1	CAP, TA, 5.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	3		
C2	CAP, TA, 5.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	REF		
C3	CAP, TA, 5.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	REF		
C4	CAP, MICA, 56 PF +/-5%, 500V	148528	72136	DM15F560J	2		
C5	CAP, MICA, 56 PF +/-5%, 500V	148528	72136	DM15F560J	REF		
C6	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	4		
C7	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C8	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C9	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
CR1	DIODE, SI, HIGH-SPEED SWITCHING	203323	07910	1N4448	1	1	
H1	SCREW, FHP, U/C, 6-32 X 1/4 (not shown)	320093	89536	320093	2		
H2	SCREW, PHP, 4-40 X 1/4	129890	73734	19022	2		
H3	SCREW, RHP, 4-40 X 3/8	256164	89536	256164	1		
J1	CONNECTOR, D, SUB-MINI	413898	71785	DB25PV	1		
MP1	CASE ASSY (INCLUDES MP2-MP8)	458943	89536	458943	1		1
MP2	CASE HALF, MODULE	402990	89536	402990	REF		
MP3	CASE HALF, MODULE, MODIFIED	412031	89536	412031	REF		
MP4	COVER MODULE CASE	402974	89536	402974	REF		
MP5	SHIELD, COVER	411983	89536	411983	REF		
MP6	DECAL, BIT SERIAL INTERFACE	413492	89536	413492	REF		
MP7	DECAL, CAUTION	454504	89536	454504	REF		
MP8	GUARD, REAR	383364	89536	383364	REF		
MP9	SHIELD, FRONT	383372	89536	383372	1		
MP10	SPRING, COIL	424465	83553	C0120-014-0380	1		
MP11	SPRING CLIP ASSY KIT	330134	02660	17-529	1		
MP12	STANDOFF	385604	89536	385604	3		
MP13	STANDOFF	312421	89536	312421	2		
MP14	TERMINAL (not shown)	179283	89536	179283	3		
MP15	TERMINAL (not shown)	208363	89536	208363	6		
Q1	XSTR, NPN, SI	218396	04713	2N3904	1	1	
Q2	XSTR, PNP, SI	226290	04713	MPS3640	1	1	
Q3	XSTR, PNP, SI	195974	04713	2N3906	1	1	
R1	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	2		
R2	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K	1		
R3	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	1		
R4	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	REF		
R5	RES, COMP, 10M +/-5%, 1/4W	194944	01121	CB1065	1		
R6	RES, DEP. CAR, 33K +/-5%, 1/4W	348888	80031	CR251-4-5P33K	1		
R7	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	2		
R8	RES, DEP. CAR, 2.2K +/-5%, 1/4	343400	80031	CR251-4-5P2K2	1		
R9	RES, DEP. CAR, 47 +/-5%, 1/4W	441592	80031	CR251-4-5P47E	1		
R10	RES, DEP. CAR, 750 +/-5%, 1/4W	441659	80031	CR251-4-5P750E	1		
R11	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7	3		
R12	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7	REF		

Table 606-5. Bit Serial Asynchronous Interface PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
R13	RES, DEP. CAR, 620 +/-5%, 1/4W	442319	80031	CR251-4-5P620E	1		
R14	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R15	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7	REF		
S1	SWITCH, SPST, 8-POS.	414490	00779	435166-5	1		
U1	IC, TTL, DUAL EIA/MIL LINE RECEIVER	354704	18324	8T16A	1	1	
U2⊗	IC, C-MOS, HEX BUFFER INVERTER	381848	02735	CD4049UBE	1	1	
U3⊗	IC, C-MOS, PRGMBLE BIT RATE GEN	418731	07263	F4702/34702	1	1	
U4	IC, TTL, MSI, DUAL EIA/MTL	354696	18324	N8T15A	1	1	
U5⊗	IC, C-MOS, DUAL "D" FLIP-FLOP	340117	02735	CD4013AE	1	1	
U6⊗	IC, C-MOS, NAND GATES, TRIPLE, 3-INPUT	375147	02735	CD4023AE	2	1	
U7⊗	IC, C-MOS, NAND GATES, TRIPLE, 3-INPUT	375147	02735	CD4023AE	REF		
U8⊗	IC, C-MOS, TRI, HEX, NON INV BUFFERS	407759	12040	MM80C97N	1	1	
U9	IC, UA, RECEIVER TRANSMITAL	354753	05828	AY-5-1013	1	1	
U10⊗	IC, C-MOS, TRIPLE, 3-INPUT AND GATE	408807	02735	CD4073BE	1	1	
U11⊗	IC, C-MOS, QUAD, 2-INPUT NAND GATE	355198	02735	CD4011AE	1	1	
U12⊗	IC, C-MOS, HEX, INV BUFFER	381830	02735	CD4050AE	1	1	
U13⊗	IC, C-MOS, HEX, INV BUFFER	381830	02735	CD4050AE	REF		
V1	CRYSTAL, QUARTZ	435370	89536	435370	1		
XU9	SOCKET, IC, 40-PIN	429282	09922	DILB40P-108	1		

1 ORDER P/N 458943 FOR COMPLETE MODULE CASE ASSY., WITHOUT PCB ASSY.

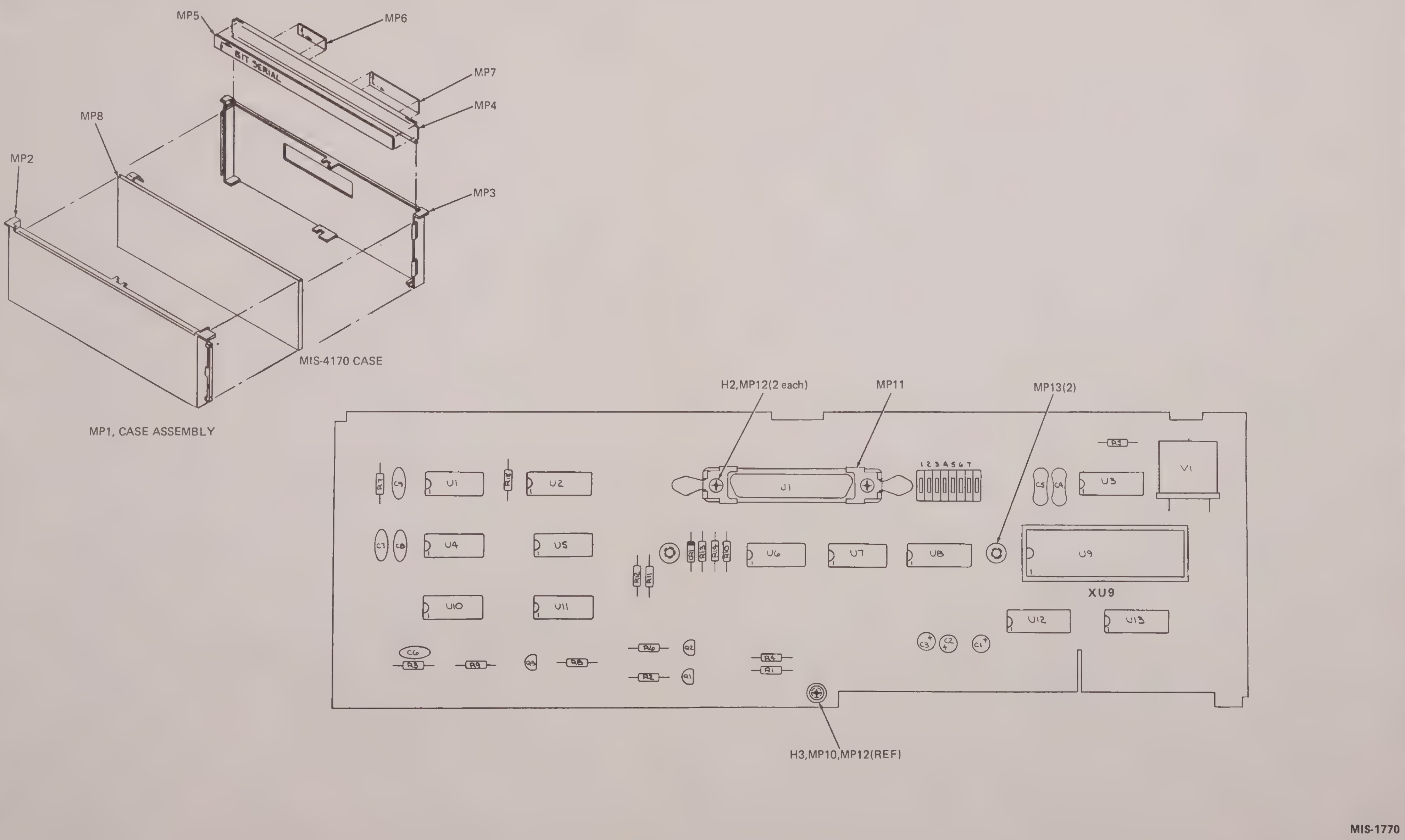
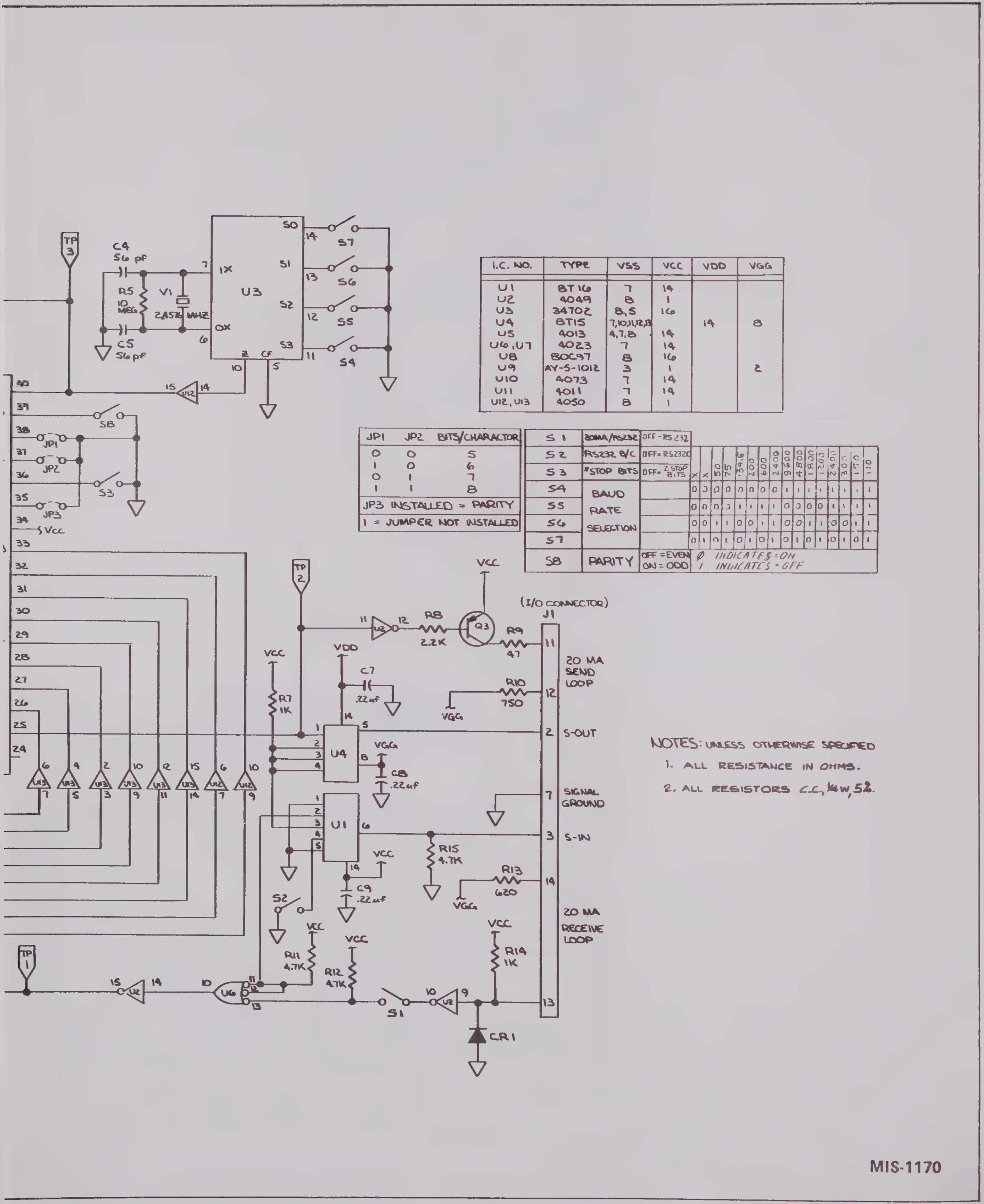

MP5
MP6
BIT SERIAL
MP7
MP4
MP8
MP2
MP3
MIS-4170 CASE
MP1, CASE ASSEMBLY
H2,MP12(2 each)
MP11
MP13(2)
R3
V1
1 2 3 4 5 6 7
R7
C9
U1
R18
U2
J1
C5
C4
U3
C7
C8
U4
U5
R13
R14
R15
R10
U6
U7
U8
U9
R12
R11
XU9
U10
U11
U12
U13
C6
R3
R9
Q3
R8
R6
Q2
R2
Q1
R4
R1
C3
C2
C1
H3,MP10,MP12(REF)
MIS-1770

Figure 606-2. Bit Serial Asynchronous Interface PCB Assembly


TP 3
C4
56 pf
R5
10 MEG
V1
2.4576 MHZ
C5
56 pf
U3
1X
OX
S0
S1
S2
S3
S7
S6
S5
S4
S8
S3
JP1
JP2
JP3
Vcc
TP 2
TP 1
VCC
VDD
VGG
C7
.22uf
R7
1K
U4
C8
.22uf
U1
C9
.22uf
R8
2.2K
Q3
R9
47
R10
750
R13
620
R15
4.7K
R11
4.7K
R12
4.7K
R14
1K
S2
S1
U6
U2
U12
U13
CR1
(I/O CONNECTOR)
J1
20 MA SEND LOOP
S-OUT
SIGNAL GROUND
S-IN
20 MA RECEIVE LOOP
MIS-1170

I.C. NO.	TYPE	VSS	VCC	VDD	VGG
U1	8T16	7	14		
U2	4049	8	1		
U3	34702	8,5	16		
U4	8T15	7,10,11,12,13		14	8
U5	4013	4,7,8	14		
U6,U7	4023	7	14		
U8	80C97	8	16		
U9	AY-5-1012	3	1		2
U10	4073	7	14		
U11	4011	7	14		
U12, U13	4050	8	1		

JP1	JP2	BITS/CHARACTOR
0	0	5
1	0	6
0	1	7
1	1	8
JP3 INSTALLED = PARITY		
1 = JUMPER NOT INSTALLED		

			X	X	50	75	134.5	200	600	2400	9600	4800	1800	1200	2400	300	150	110
S1	20MA/RS232	OFF - RS 232																
S2	RS232 B/C	OFF=RS232C																
S3	#STOP BITS	OFF= 2 STOP BITS																
S4	BAUD RATE SELECTION		0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
S5			0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
S6			0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
S7			0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
S8	PARITY	OFF = EVEN ON = ODD	0 INDICATES = ON 1 INDICATES = OFF															

NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTANCE IN OHMS.
2. ALL RESISTORS C.C., ¼W, 5%.

Figure 606-2. Bit Serial Asynchronous Interface PCB Assembly (cont)

Option -07
Parallel Interface

607-1. INTRODUCTION

607-2. Installation of the Parallel Interface provides external programming capability in mini- and microcomputer systems. Program inputs must be in ASCII code. Outputs are remotely selectable between ASCII or binary (2's complement) and 8 or 16 bit characters.

607-3. Interfacing to a wide variety of devices is accomplished with a plug-in header termed a "personality card". By defining the pins, this card can be tailored to perform control of the DMM through the external device. Table 607-1 lists pins and definitions for the personality card. The personality card plugs into J2, as seen in Figure 607-1. Available personality cards are listed in Table 607-2.

607-4. Descriptions unique to the Parallel Interface will be provided separately from Programming Instructions in this manual. The Systems Multimeter Programming Card provided with the DMM lists condensed programming instructions. Fluke Application Bulletin #25 contains useful information concerning the use of the Parallel Interface.

Table 607-1. Personality Card Pin Definition

PIN NO.	INTERFACE MNEMONIC	BOARD - PIN DEFINITION
1	COS-B	= Control Output Strobe Buffered
2	$\overline{\text{COS-B}}$	= Control Output Strobe Inverted Buffered
3	COS	= Control Output Strobe
4	OR2A	= OR Gate 2 Input A
5	OR2B	= OR Gate 2 Input B
6	OR2A + OR2B	= OR Gate 2 Output
7	$\overline{\text{COS-B}}$	= Control Output Strobe Inverted Buffered
8	COEN	= LSB Output Enable
9	DOEN	= MSB Output Enable
10	OSLE	= Output Strobe Latch Enable
11	ILAT	= Data Input MSB Latch
12	SLAT	= Control Input LSB Latch
13	ISLE	= Input Strobe Latch Enable
14	ILS	= Data Input Latch Strobe

Table 607-1. Personality Card Pin Definition (cont)

PIN NO.	INTERFACE MNEMONIC	BOARD-PIN DEFINITION
15	SLS	= Control Input Latch Strobe
16	DLR	= Data Output Latch Reset
17	CLR	= Control Output Latch Reset
18	QP	= High Output Delay Pulse
19	GND	= Ground
20	VCC	= +5V dc
21	$\overline{\text{INT}}$	= Interrupt Clock
22	$\overline{\text{CIS}}$	= Control Input Strobe Clock Inverted
23	$\overline{\text{QP}}$	= Low Output Delay Pulse
24	$\overline{\text{CIS-B}}$	= Control Input Strobe Inverted Buffered
25	$\overline{\text{IQ}}$	= Data Input Ready Low
26	IQ	= Data Input Ready High
27	$\overline{\text{DQ}}$	= Data Output Ready Low
28	DQ	= Data Output Ready High
29	TTL PU	= TTL Pull Up
30	OR1A	= OR Gate 1 Input A
31	OR1B	= OR Gate 1 Input B
32	OR1A + OR1B	= OR Gate 1 Output
33	$\overline{\text{CIS B}}$	= Control Input Strobe Inverted Buffered
34	CIS B	= Control Input Strobe Buffered
35	CIS	= Control Input Strobe
36	NC	= No Connection
37	HT	= High Trigger Delay Pulse
38	$\overline{\text{COR}}$	= Control Output Ready Inverted
39	LT	= Low Trigger Delay Pulse
40	$\overline{\text{CIR}}$	= Control Input Ready Inverted

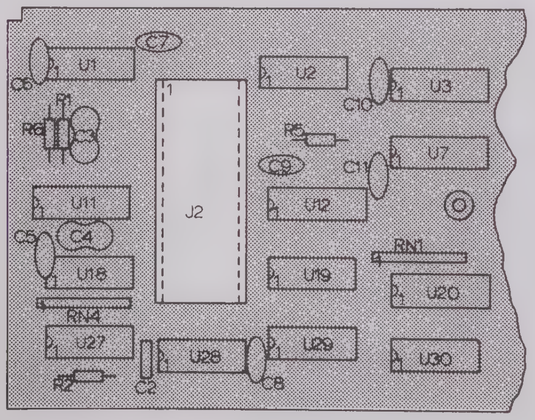


Figure 607-1. Personality Card Location

Table 607-2. Personality Cards

DESIGNATION	DESCRIPTION
-07A	Duplex Parallel Interface for PDP-11, DR11C, DRV-11.
-07B	Duplex Parallel Interface for PDP-11, PC11.
-07D	Duplex Parallel Interface (wiring completed by user).
-07H	Duplex Parallel Interface for HP12566B, 9825A.
-07L	Similar to the 07A, but used in noisier systems.

607-5. INSTALLATION

607-6. The Parallel Interface is easily installed as a module in the 8500 series DMM. Use the following installation procedure:

1. On the DMM, press power OFF and remove the line power cord.

2. Remove the DMM's top cover.

3. Ensure that the desired personality card is installed on the Interface PCB. If necessary, refer to "Module Disassembly" in Section 4 of the Instruction Manual when accessing the Interface PCB.

NOTE

If the -07L Personality Card is used remove jumpers W1 and W2 from the Interface PCB.

4. Plug the personality card into J2 on the Parallel Interface PCB. The location of J2 is illustrated in Figure 607-1.

5. Reassemble the module (PCB and shield covers).

6. The Interface module fits in the rearmost slot, bus connector and address switches facing the rear. Slide the module vertically between the module guides, and press firmly into place.

NOTE

Make sure the leaf spring, attached to one-half of the module shield, is resting firmly over the flange of the opposite half of the module shield.

7. Remove the Interconnect PCB, if installed, from slot K. This slot can be identified as the only one with connectors on the analog and digital bus lines. To remove the Interconnect PCB, grasp the board at both ends, and pull up. An end-to-end rocking motion may be necessary to free the PCB from its connectors. The Isolator module must be installed in slot K whenever a remote interface (Option -05, -06 or -07) is used in the DMM.

NOTE

Use Isolator -08 with the 8500A; Isolator -08A must be used with the 8502A.

8. Replace the DMM's top cover.

9. Energize the DMM.

607-7. OPERATING DIRECTIONS

607-8. The normal power-up condition of the Parallel Interface is eight-bit ASCII input and output. Command codes can change this to 16-bit ASCII input (two characters per transfer), 16-bit ASCII output, 8-bit Binary output, or 16-bit Binary output in character serial format.

607-9. When the front panel remote switch is pressed on the 8500A, the DMM stops measurements and waits for stimulation from the external device. On the 8502A, pressing the front panel remote switch results in the Parallel Interface trying to output data (ASCII 8-bit) in a continuous talk only mode.

607-10. THEORY OF OPERATION

607-11. Block Diagram Analysis

607-12. Data transfer through the Parallel Interface involves handshake processes between the interface and either the system controller or the instrument controller. Refer to the Block Diagram, Figure 607-2, during the following descriptions.

607-13. At power on, a reset circuit in the interface holds the control latches in the proper state until Vcc stabilizes. The instrument controller sends a software reset and an interrupt enable signal to the interface during its power on routine. This enables I/O operations to proceed.

607-14. This paragraph describes a typical two-wire handshake process for transferring commands through the interface to the DMM. Before the system controller attempts to send data to the instrument it verifies that the DMM is ready to accept the data. If the Control Input Ready (CIR) handshake signal indicates the DMM is ready, the system controller can strobe the Control Input Strobe (CIS) handshake signal line. The CIS has three functions. One clocks the input data placed by system controller on the input lines into the data input latches of the -07 interface. The second generates an interrupt request to the instrument controller. The last toggles the CIR handshake signal to indicate that the DMM is not ready and cannot accept additional input data. The CIS interrupts the DMM which responds by accepting the input data from the -07 interface data input latches and toggling the CIR handshake signal to indicate that the -07 interface is now ready to accept additional data from the system controller. This process is repeated for each input operation

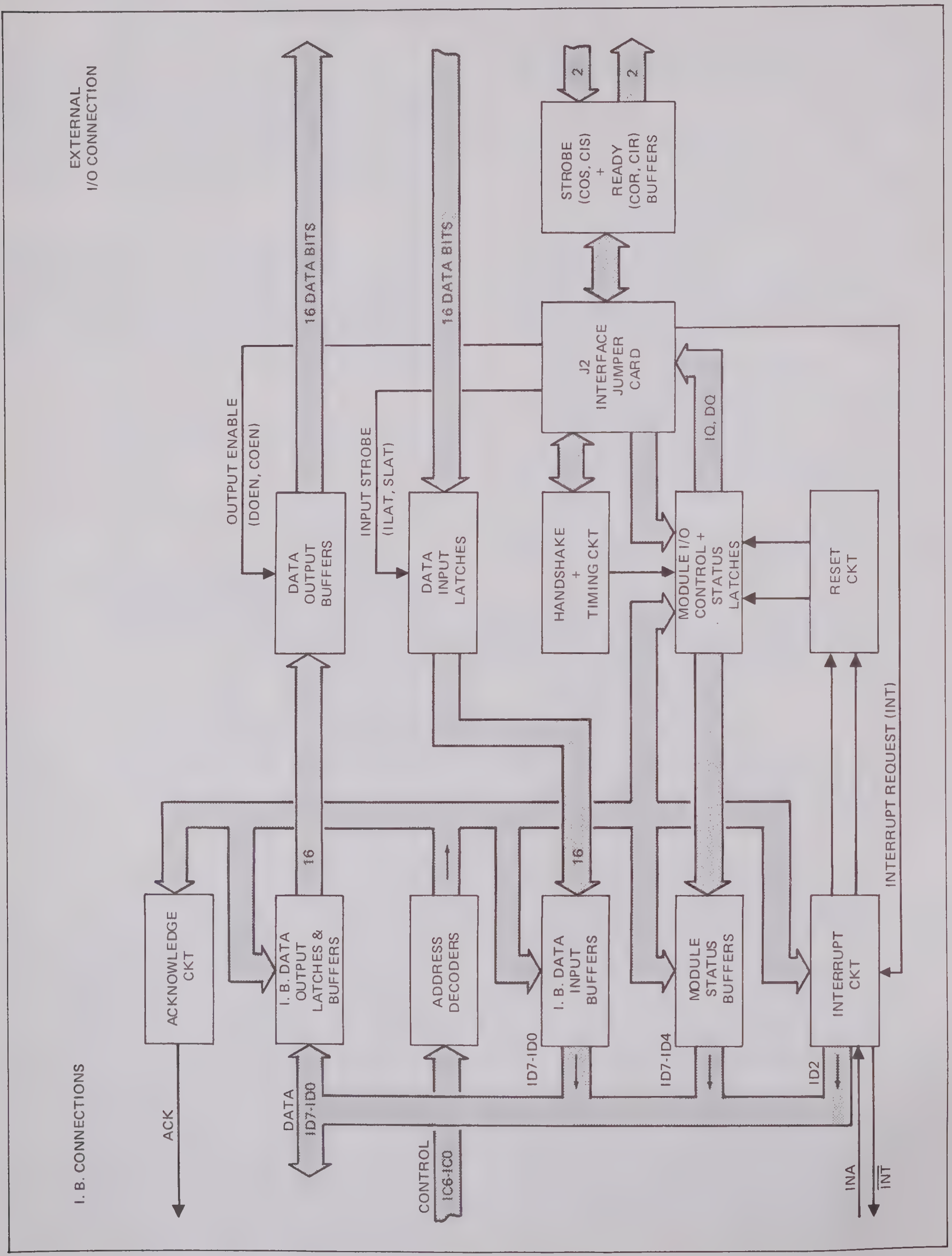

EXTERNAL
I/O CONNECTION
I. B. CONNECTIONS
16 DATA BITS
16 DATA BITS
2
2
STROBE
(COS, CIS)
+
READY
(COR, CIR)
BUFFERS
J2
INTERFACE
JUMPER
CARD
OUTPUT ENABLE
(DOEN, COEN)
INPUT STROBE
(ILAT, SLAT)
IQ, DQ
DATA
OUTPUT
BUFFERS
DATA
INPUT
LATCHES
HANDSHAKE
+
TIMING CKT
MODULE I/O
CONTROL +
STATUS
LATCHES
RESET
CKT
INTERRUPT REQUEST (INT)
16
16
ACKNOWLEDGE
CKT
I. B. DATA
OUTPUT
LATCHES &
BUFFERS
ADDRESS
DECODERS
I. B. DATA
INPUT
BUFFERS
MODULE
STATUS
BUFFERS
INTERRUPT
CKT
ACK
DATA
ID7-ID0
CONTROL
IC6-IC0
ID7-ID0
ID7-ID4
ID2
INA
$\overline{\text{INT}}$

Figure 607-2. Parallel Interface Block Diagram

607-15. A typical two-wire data output transaction from the DMM is handled in a similar manner to the command input operation described above. When a data output transaction is initiated the instrument loads the data into the data output latches of the -07 interface and toggles the Control Output Ready (COR) handshake signal. This indicates that the -07 interface contains data to be transferred to the receiving device. The receiving device may accept the output data via the Data Out/Control Out Signal lines while enabling the Data Output Buffers. The receiving device strobes the Control Output Strobe (COS) handshake signal line either while or after it accepts the data. This toggles the COR handshake signal to indicate acceptance of the previously output data and to permit subsequent data output operations to occur. This process is repeated for each output operation.

607-16. Due to the wide variety of handshaking protocols, a personality card is used to match the logical and electrical characteristics of the system interface handshake signals to the -07 interface circuitry. The personality card connects the handshake lines to interface control and status signals. However, if the handshake protocol warrants additional circuitry may be used in the personality card connection configuration. The additional circuitry may be from either logic and timing circuitry existing on the -07 interface PCB, or additional circuitry on the personality card. Typical personality card connections have I-LAT, S-LAT, $\overline{\text{INT}}$, and SLS stimulated through the CIS handshake signal and CIR stimulated by IQ for input operations. I-LAT and S-LAT are used to store input data over the Data In and Control In signal lines. $\overline{\text{INT}}$ is used to generate the interrupt request to the instrument controller. SLS toggles the CIR signal. For output operations, COR is stimulated through DQ and COS stimulated by CLR. CLR toggles the COS signal.

607-17. Circuit Analysis

607-18. The following circuit analysis is accurate for Parallel Interface with Personality Card DR11C (4062) installed; control signals COS, CIS, COR, and CIR are therefore positive true logic. Refer to the Schematic Diagram during the following circuit descriptions. Table 607-3 defines interface connections.

607-19. RESETS

607-20. Power up resets are controlled by the RC network connected to U19-13. The reset signal is applied through U1-11 and U8-4 to the control latches (U29-8 and U28-8 are reset, while U29-5 and U28-5 are set). Address IC5, 3, 2, decoded by U25-10, provides software resets.

607-21. ADDRESSES

607-22. For all addresses, an ACK response is returned to the instrument controller through U31-10 and Q1. Upon termination of the address, U30-12 is clocked. If ID7 is high, the interface is reset through U23-10, U23-11 and U19-12 and interrrupts are disabled. If ID7 is low at address IC5, 3, and 2, interrupts are enabled, U30-12 goes high. Since U30-2 was reset, U19-6 is high; U19-4 places a high on U30-5. When U30-2 is clocked, an interrupt will be generated from U20-11. When triggered by U19-10, U11-12 goes low to clear U29-5 and U28-5. The signal from U28-5, routed through the personality card to generate CIR, indicates to the system controller that the instrument is ready to receive data.

607-23. DATA INPUTS

607-24. The system controller strobes the CIS line to make U2-2 low and applies it through the personality card to I-LAT, S-LAT, and LT. U2-4 also goes high and is applied to SLS through the personality card. I-LAT and S-LAT from the personality card clock the input data on the Data In and Control In lines into the data latches U3, U7, U13, and U14 at the termination of the CIS strobe. The termination of CIS also triggers a pulse (QP) at U11-2 through the LT signal at U11-1 which connects through the personality card to $\overline{\text{INT}}$. $\overline{\text{INT}}$, through U19-10, clocks U30-2 which enables the tri-state U20-11 to interrupt the instrument controller. SLS, through U18-8 and U27-4 clocks U28-5 (IQ) high. IQ, through the personality card and U2-6, drives CIR to indicate to the system controller that the -07 interface is not ready to accept additional data. The instrument controller responds to $\overline{\text{INT}}$ with an $\overline{\text{INA}}$ which drives U8-2 low to enable tri-state U12-13 to place a high (from U30-1) on ID2 for use as the interrupt vector in the instrument controller. INA is also applied directly to U23-2 which drives U23-3 and U19-10 low to cause an ACK response. Termination of INA clocks U30-1 low, ending the interrupt signal.

607-25. The interrupt vector tells the instrument controller to read data out of the interface. Address IC1, 4, 6 is decoded by U24-10 to enable tri-state buffers U12, U21 and U22. The low from U24-10 is applied through U27-4 to the clock input of U28-5. Termination of the address clocks IQ (U28-4) low. This state, transferred through the personality card and U2-6, causes CIR to go high and signals the system controller that the instrument is ready for more data.

607-26. In the double character mode, data of the most significant byte (DATA IN) is read first and the least significant byte (CONTROL IN) is read second. In the data output mode the MSB is loaded first. All termination and immediate command characters must use the CONTROL IN data lines.

607-27. DATA OUTPUTS

607-28. Data bytes are loaded into data latches U15, U16, U17, and U26 by addresses IC0, 3, 5 (decoded by U25-9) and IC1, 3, 5 (decoded by U25-6). Termination of the addresses also clock DQ (U28-8) low. Applied through the personality card to U2-8, this low sets COR high. The receiving device now sees that data is ready to be read from the interface.

607-29. The COS strobe is used by the receiving device to complete the output handshake. Since data output buffers U4, U5, and U6 are enabled by DOEN and COEN low through personality card connections, output data is available on Data Out and Control Out lines. The COS strobe is generated, either while or after, the receiving device accepts the data. A high on U2-10 from COS is applied through the personality card to the CLR line (U18-4) and eventually to the clock input of DQ (U28-11). Termination of COS clocks DQ high which toggles COR and informs the instrument controller that more data may be transferred to the receiving device via the -07 interface.

607-30. One complete reading in the 16-bit mode consists of seven transfers in ASCII (six with line feed suppression), or three transfers in binary code. Each reading in the eight bit mode consists of fourteen transfers in ASCII (thirteen with line feed suppression) or five transfers in binary code. When a complete reading has been sent in either mode, the instrument controller resets the interface and enables interrupts. CIR goes high to indicate that the instrument is ready to receive data.

607-31. Detailed Input Processes Description

607-32. For a graphical representation of the signal timing relationships, refer to Figure 607-3 and Table 607-4. Before inputting any information to the DMM, the -07 interface must indicate that it is ready to accept input data. This is

Table 607-3. Parallel Interface Connections

TITLE	MNEMONIC	J1 PIN NO.	SIGNAL FLOW
Input Strobe	CIS	31	From Control Device
Output Strobe	COS	37	From Control Device
MSD Bit 15 Input	I7	14	From Control Device
MSD Bit 14 Input	I6	15	From Control Device
MSD Bit 13 Input	I5	16	From Control Device
MSD Bit 12 Input	I4	17	From Control Device
MSD Bit 11 Input	I3	18	From Control Device
MSD Bit 10 Input	I2	19	From Control Device
MSD Bit 9 Input	I1	20	From Control Device
MSD Bit 8 Input	I0	21	From Control Device
LSD Bit 7 Input	S7	6	From Control Device
LSD Bit 6 Input	S6	7	From Control Device
LSD Bit 5 Input	S5	8	From Control Device
LSD Bit 4 Input	S4	9	From Control Device
LSD Bit 3 Input	S3	10	From Control Device
LSD Bit 2 Input	S2	11	From Control Device
LSD Bit 1 Input	S1	12	From Control Device
LSD Bit 0 Input	S0	13	From Control Device
Output Ready	COR	1	To Control Device
Input Ready	CIR	29	To Control Device
MSD Bit 15 Output	D7	46	To Control Device
MSD Bit 14 Output	D6	45	To Control Device
MSD Bit 13 Output	D5	44	To Control Device
MSD Bit 12 Output	D4	43	To Control Device
MSD Bit 11 Output	D3	42	To Control Device
MSD Bit 10 Output	D2	41	To Control Device
MSD Bit 9 Output	D1	40	To Control Device
MSD Bit 8 Output	D0	39	To Control Device
LSD Bit 7 Output	C7	22	To Control Device
LSD Bit 6 Output	C6	23	To Control Device
LSD Bit 5 Output	C5	24	To Control Device
LSD Bit 4 Output	C4	25	To Control Device
LSD Bit 3 Output	C3	50	To Control Device
LSD Bit 2 Output	C2	49	To Control Device
LSD Bit 1 Output	C1	48	To Control Device
LSD Bit 0 Output	C0	47	To Control Device

reflected by Data Input Ready Indicator, IQ or $\overline{IQ}$. The Data Ready Indicator, DQ, is at a low level when the DMM is ready to accept data (prior to T9). (Conversely, $\overline{DQ}$ is at a high level to reflect this condition.) With this indicating ready, data on data lines I0-I7 and S0-S7 if appropriate, can be strobed into the data latches. This is done by a low to high transition on ILAT and SLAT as appropriate (T4). (S0-S7 and SLAT are only used for 16 bit mode input operations.)

607-33. The Data Input Ready Indicator must be toggled to reflect that the interface is no longer able to accept data. ISLE and SLS are used to toggle Data Input Ready. The logical NAND of ISLE and SLS is formed. This signal is termed $\overline{CIS}$. With both ISLE and SLS in a high state, the high to low transition of SLS toggles the Indicator (T7). $\overline{CIS}$ is low with both ISLE and SLS high. The high to low transition of SLS causes a low to high transition on $\overline{CIS}$ (T8), toggling the Data Input Ready Indicator (T9). $\overline{CIS}$ must remain high until the input cycle is complete. This means that both ISLE and SLS must not be high simultaneously again until the completion of the input cycle (T12).

607-34. To initiate processing of the data from the interface into the DMM, a low going pulse must be placed on $\overline{INT}$. Its trailing edge initiates the activity (T13). $\overline{INT}$ must not again make a low to high transition until the subsequent input transaction.

607-35. Following the $\overline{INT}$ signal, the DMM is processing the data from its interface. When it has completed this processing, it will toggle the Data Input Ready Indicator (T12). When this has occurred, the DMM input operation is complete. Additional data may now be transferred to the interface from the external device as necessary.

607-36. Detailed Output Processes Description

607-37. For a graphical representation of the signal timing relationships, refer to Figure 607-4 and Table 607-5. An output cycle is started by the DMM indicating that its interface contains data to be transferred to the external device. This is shown by the Data Output Ready Indicator, DQ or $\overline{DQ}$. DQ is at a low level and $\overline{DQ}$ is at a high level when output data is available from the DMM (prior to T2).

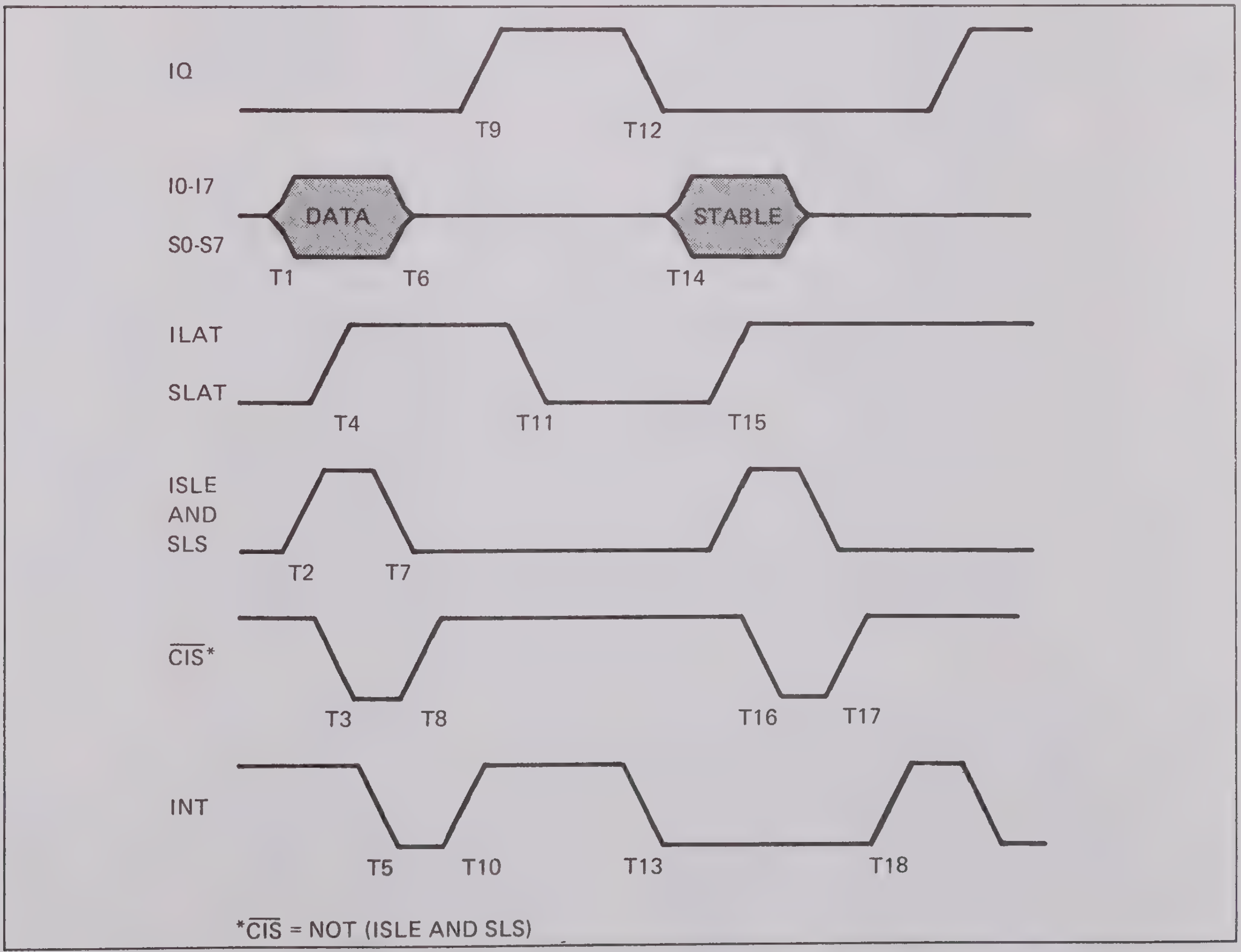


Figure 607-3. Interface Input Control Signal Timing Diagram

Table 607-4. Input Timing Parameters

T_1-T_4	5 ns	Data set up time preceding SLAT or ILAT low to high transition
T_4-T_6	3 ns	Data hold time following SLAT or ILAT low to high transition
T_{12}-T_{14}	0 ns	Minimum wait time following the ready transition of IQ or $\overline{\text{IQ}}$ before new data can be placed on data lines
T_4-T_{11}	10 ns	Minimum time SLAT or ILAT can be high
T_{11}-T_{15}	3 ns	Minimum time SLAT or ILAT can be low
T_3-T_8	250 ns	Maximum time from when ISLE and SLS both become high to the high to low transition of $\overline{\text{CIS}}$
T_7-T_8	250 ns	Maximum time from when either ISLE or SLS become low to when $\overline{\text{CIS}}$ becomes high
T_8-T_9	300 ns	Time for the low to high transition of CIS to toggle IQ or $\overline{\text{IQ}}$
T_{16}-T_{17}	15 ns	Minimum time $\overline{\text{CIS}}$ may be low
T_{12}-T_{16}	0 ns	Minimum wait time following the ready transition of IQ until $\overline{\text{CIS}}$ may enter a low condition
T_5-T_{10}	500 ns	Minimum time for $\overline{\text{INT}}$ to remain low preceding the low to high transition
T_{10}-T_{12}	500 ns	Typical time for IQ or $\overline{\text{IQ}}$ to respond to $\overline{\text{INT}}$ transition (8 bit mode)
	920 ns	Typical time for IQ or $\overline{\text{IQ}}$ to respond to $\overline{\text{INT}}$ transition (16 bit mode)
T_{10}-T_{13}	500 ns	Minimum time $\overline{\text{INT}}$ must remain high
T_{17}-T_{18}	0 ns	Minimum wait time following the $\overline{\text{CIS}}$ transition before the $\overline{\text{INT}}$ transition

607-38. At this point, data is stored in latches on the -07 interface (T3). For this data to be on data lines C0-C7 and D0-D7 if appropriate, the output driver circuitry must be enabled. A low level on COEN enables the data line drivers on C0-C7. Similarly, a low level on DOEN enables data line drivers on D0-D7. D0-D7 need only to be enabled when data is transferred in the two byte, 16 bit format. A high level on either of these enable lines disables the tri-state drive circuitry and presents a high impedance to the appropriate data lines from the interface.

Table 607-5. Output Timing Parameters

T_1-T_3	40 ns	Minimum enabling time for data line driving circuitry
T_{10}-T_{11}	30 ns	Minimum disabling time for data line driving circuitry
T_2-T_3	1170 ns	Minimum time from data ready transition until valid data
T_2-T_4	0 ns	Minimum time following ready transition until start of ready toggle pulse
T_4-T_5	250 ns	Maximum time from when both CLR and OSLE become high until $\overline{\text{DQTGL}}$ makes a high to low transition
T_6-T_7	250 ns	Maximum time for $\overline{\text{DQTGL}}$ to make a low to high transition following either CLR or OSLE becoming high
T_5-T_7	15 ns	Minimum ready toggle pulse time
T_7-T_8	315 ns	Time to toggle the ready indicator following the toggle pulse
T_8-T_9	1 us	Time following ready indicator toggle before data is not valid

607-39. With the acceptance of the data from the interface, the external device must toggle the Data Output Ready Indicator. This indicates that the output cycle is complete. Subsequent operations may then proceed (such as another output cycle, another measurement, subsequent command processing, etc.). To toggle the Data Output Ready Indicator, OSLE and CLR are used. OSLE and CLR are NANDed together to generate the signal which toggles the Data Output Ready Indicator. (This combined signal is termed $\overline{\text{DQTGL}}$ in the timing diagram.) A rising edge on this signal toggles the indicator (T7). From the completion of the previous output cycle, OSLE and CLR cannot both be at a high level simultaneously. One or the other or both must be low at all times. To toggle the indicator, both OSLE and CLR should be at or change to a high state (T4), and then CLR should make a high to low transition (T6). The Output Data Ready Indicator toggles (T8) and completes the output cycle.

607-40. TROUBLESHOOTING

607-41. Troubleshooting the Parallel Interface requires an external control device with a parallel I/O, such as a PDP 11 with the DR11C Interface. When a problem is isolated to the Parallel Interface, it is recommended that the faulty unit be sent to the nearest service center for repair. Table 607-6 additionally provides a tabular flow chart approach to troubleshooting. When a step on the flow chart is completed, check for a decision transfer. If no decision is required, perform the next step in sequence.

607-42. PROGRAMMING INSTRUCTIONS

607-43. Programming command instructions are provided in Table 607-7. For the 8505A and 8506A, refer to Section 2A.

607-44. PARTS LIST

607-45. Table 607-7 gives a parts breakdown for the Parallel Interface. Refer to Section 5 of this manual for ordering information.

CAUTION

Indicated devices are subject to damage by static discharge.

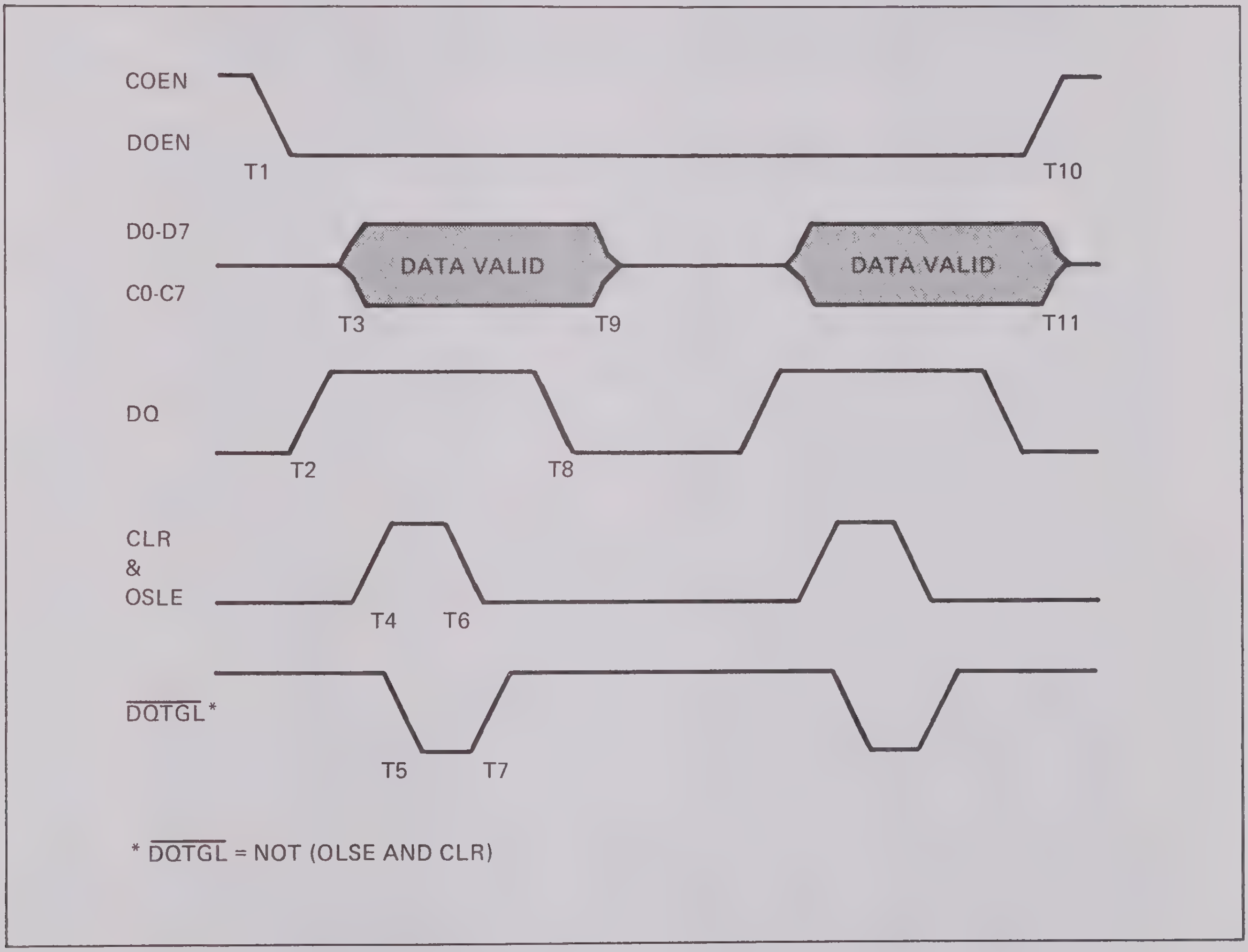

COEN
DOEN
T1
T10
D0-D7
C0-C7
DATA VALID
DATA VALID
T3
T9
T11
DQ
T2
T8
CLR
&
OSLE
T4
T6
$\overline{\text{DQTGL}}$*
T5
T7
* $\overline{\text{DQTGL}}$ = NOT (OLSE AND CLR)

Figure 607-4. Interface Output Control Signal Timing Diagram

Table 607-6. Troubleshooting

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	This troubleshooting procedure is based on the assumption that the instrument has been checked in local and found to be operational in all aspects prior to installation of the Parallel Interface.		
2	Install the Parallel Interface in the instrument and apply power from the front panel switch.		
3	Is the display blank?	4	6
4	Check for an address (IC) line held low. Check the address decoders.		
5	Check for the ACK line held high. Check the ACK circuitry. Repair as required and return to step 2.		
6	Is the wrong option configuration displayed at power on or reset?	7	8
7	Check for an address (IC) line held high. Check the address decoder. Repair as required and return to step 2.		
8	Is the display incorrect or garbled?	9	10
9	Check for an ID line held high or low. Check the input latch, output buffer, and INT set flip-flop.		
10	Instruct the instrument to go to remote by inputting a valid program character. Does the instrument go to remote?	12	11
11	Check the input strobe (CIS) J2-34; check for the INT circuit not being set (U30,19); check for the INT from the input strobe (J2-21).		
12	Select a mode from remote. Is the right mode selected?	14	13
13	Check the input data latches or buffers. Check the data strobe at J2-22, -12.		
14	Check the response data. Is there any, or is it correct?	16	15
15	Check the ready (COR) line. Check the output strobe (COS). Check the output latches or buffer.		
16	Is the response only a single byte of data?	17	18
17	Check the status flip-flops (U28, U29) for reset.		
18	Is the ready line hung?	18	19
19	Check for incorrect data out or bad input data.		
20	If there is no input, check for a bad input ready (CIR).		
21	Troubleshooting of the Parallel Interface as applicable at this level, is complete.		

Table 607-7. Parallel Interface PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
-07⊗	PARALLEL INTERFACE PCB ASSEMBLY FIGURE 607-5 (MIS-4175T)	ORDER	BY	OPTION -07			
C1	CAP, TA, 5.6 UF +/-20%, 25V	368969	56289	196D565X0025KA1	1		
C2	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	1		
C3	CAP, MICA, 100 PF +/-1%, 500V	226126	72136	DM15F101F	1		
C4	CAP, MICA, 390 PF +/-5%, 500V	148437	72136	DM15F391J	1		
C5	CAP, CER, 560 PF +/-10%, 600V	106203	72982	801-00-X5R0-561K	1		
C6-C12	CAP, CER, 0.01 UF +/-20%, 100V	149153	56289	C023B101F103M	7		
H1	SCREW, PHP, 4-40 X 1/4	129890	73734	19022	2		
H2	SCREW, PHP, 4-40 X 3/8	256164	89536	256164	1		
H3	WASHER, INT/LK #4	110403	73734	99402	2		
H4	SCREW, FHP, 6-32 X 1/4 (not shown)	320093	89536	320093	2		
J2	CONNECTOR, SOCKET, 20 PIN	447110	89536	447110	2		
MP1	CASE ASSY (INCLUDES MP2-MP8)	458950	89536	458950	1		
MP2	CASE, HALF	402990	89536	402990	REF		
MP3	CASE HALF, MODULE	427625	89536	427625	REF		
MP4	COVER, MODULE CASE	402974	89536	402974	REF		
MP5	SHIELD, COVER	411991	89536	411991	REF		
MP6	DECAL, PARALLEL INTERFACE	413500	89536	413500	REF		
MP7	DECAL, CAUTION	454504	89536	454504	REF		
MP8	GUARD, REAR	383364	89536	383364	REF		
MP9	LATCH	412700	13511	57-1001	2		
MP10	SPRING, COIL	424465	83553	C0120-014-0380	1		
	(not shown)						
MP11	SPRING, CONNECTOR	412718	71785	436-99-22-205	2		
MP12	SHIELD, FRONT (not shown)	383372	89536	383372	1		
MP13	SPACER, SWAGED	312421	89536	312421	2		
MP14	SPACER, SWAGED	335604	89536	335604	3		
P1	CONNECTOR, CABLE, 50-PIN, MODIFIED	413138	13511	57-20500-31	1		
Q1	XSTR, SI, PNP	226290	04713	MPS3640	1		1
R1	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	2		
R2	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	2		
R3	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
R4	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	1		
R5	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R6	RES, DEP. CAR, 2K +/-5%, 1/4W	441469	80031	CR251-4-5P2K	1		
R7	RES, DEP CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	1		
RN1-RN4⊗	RESISTOR NETWORK, 4.7K, 8-PINS	412916	89536	412916	4		
U1	IC, TTL, 2-INPUT POS OR GATE	393108	01295	SN74LS32N	1		1
U2	IC, TTL, POS NAND GATES	292979	01295	SN7404N	1		1
U3	IC, TTL, LO-PWR SCHOTTKY	393215	01295	SN74S175N	4		1
U4-U6	IC, TTL, TRISTATE, HEX BUFFERS	408765	01295	SN74367N	3		1
U7	IC, TTL, LO-PWR SCHOTTKY	393215	01295	SN74S175N	REF		
U8⊗	IC, C-MOS, HEX INVERTER/BUFFER	381848	02735	CD4049AE	1		1
U9, U10⊗	IC, C-MOS, HEX INVERTER/BUFFER	381830	02735	CD4050AE	2		1
U11⊗	IC, LO-PWR SCHOTTKY	404186	01295	SN74LS123N	1		1
U12⊗	IC, MOS, TRISTATE HEX BUFFER	407759	12040	MM80C97N	4		1

Table 607-8. Parallel Interface PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
U13	IC, TTL, LO-PWR SCHOTTKY	393215	01295	SN74S175N	REF		
U14	IC, TTL, LO-PWR SCHOTTKY	393215	01295	SN74S175N	REF		
U15-U17⊗	IC, COS/MOS, QUAD, CLOCKED D LATCH	355149	02735	CD4042AE	4	1	
U18⊗	IC, TTL, QUAD, 2-INPUT POS NAND GATE	393033	01295	SN74LSOON	1	1	
U19⊗	IC, C-MOS, QUAD, 2-INPUT, AND GATE	408401	02735	CD4081BE	2	1	
U20-U22⊗	IC, MOS, TRISTATE HEX BUFFER	407759	12040	MM80C97N	REF		
U23⊗	IC, C-MOS, QUAD, 2-INPUT NAND GATES	355198	02735	CD4011AE	1	1	
U24, U25⊗	IC, C-MOS, TRPL, 3-INPUT NAND GATE	375147	02735	CD4023AE	2	1	
U26⊗	IC, COS/MOS, QUAD, CLOCKED D LATCH	355149	02735	CD4042AE	REF		
U27⊗	IC, C-MOS, QUAD, 2-INPUT, AND GATE	408401	02735	CD4081BE	REF		
U28, U29	IC, LO-PWR SCHOTTKY	393124	01295	SN74LS74N	2	1	
U30⊗	IC, C-MOS, DUAL TYPE "D" FLIP-FLOP	340117	02735	CD4013AE	1	1	
U31⊗	IC, C-MOS, TRIPLE 3-INPUT, AND GATE	408807	02735	CD4073B	1	1	
	DR11-C, LN1 PERSONALITY CARD PCB ASSY (MIS-4062) (NOT SHOWN)	523043	89536	523043			
CR1	DIODE, SI, HIGH-SPEED SWITCHING	203323	07910	1N4448	4	1	
CR2	DIODE, SI, HIGH-SPEED SWITCHING	203323	07910	1N4448	REF		
CR3	DIODE, SI, HIGH-SPEED SWITCHING	203323	07910	1N4448	REF		
CR4	DIODE, SI, HIGH-SPEED SWITCHING	203323	07910	1N4448	REF		
MP1	CONNECTOR, POST	267500	00779	87022-1	40		
R1	RES, COMP, 4.7K +/-5%, 1/4W	148072	01121	CB4725	1		
	DR11-C, HN1 PERSONALITY CARD PCB ASSY (MIS-4063) (NOT SHOWN)	523068	00779	87022-1	40		
	PC11 PERSONALITY CARD PCB ASSY (MIS-4069) (NOT SHOWN)	449447	89536	449447			
	SFH PERSONALITY CARD PCB ASSY (MIS-4070) (NOT SHOWN)	449454	89536	449454			
	GP PERSONALITY CARD PCB ASSY	449462	89536	449462			
	(MIS-4071) (NOT SHOWN)						
CR1	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	4	1	
CR2	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR3	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR4	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
MP1	CONNECTOR, POST	267500	00779	87022-1	40		
	HP PERSONALITY CARD PCB ASSEMBLY (MIS-4067T) (NOT SHOWN)	476218	89536	476218	1		
C1	CAP, CER, 0.01 UF +/-20%, 100V	407361	72982	8121-A100-W5R-103M	1		
C2	CAP, MICA, 100 PF +/-5%, 500V	148494	72136	DM15F101J	1		
R1	RES, DEP. CAR, 330 +/-5%, 1/4W	368720	80031	CR251-4-5P330E	2		
R2	RES, DEP. CAR, 220 +/-5%, 1/4W	342626	80031	CR251-4-5P220E	2		
R3	RES, DEP. CAR, 330 +/-5%, 1/4W	368720	80031	CR251-4-5P330E	REF		
R4	RES, DEP. CAR, 220 +/-5%, 1/4W	342626	80031	CR251-4-5P220E	REF		
R5	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	1		
U1	IC, TTL, QUAD, 2-INPUT, POS AND GATES	393066	01295	SN74LS08	1	1	
U2	IC, TTL, LO-PWR SCHTKY MNSTB MULTVBRS	404186	01295	SN74LS123N	1	1	

THE DR11-C/HN1, PC11, SFH, AND GP PERSONALITY CARDS HAVE THE SAME COMPONENT PARTS.

1 ORDER P/N 458950 FOR COMPLETE MODULE CASE ASSY., WITHOUT PCB ASSY.

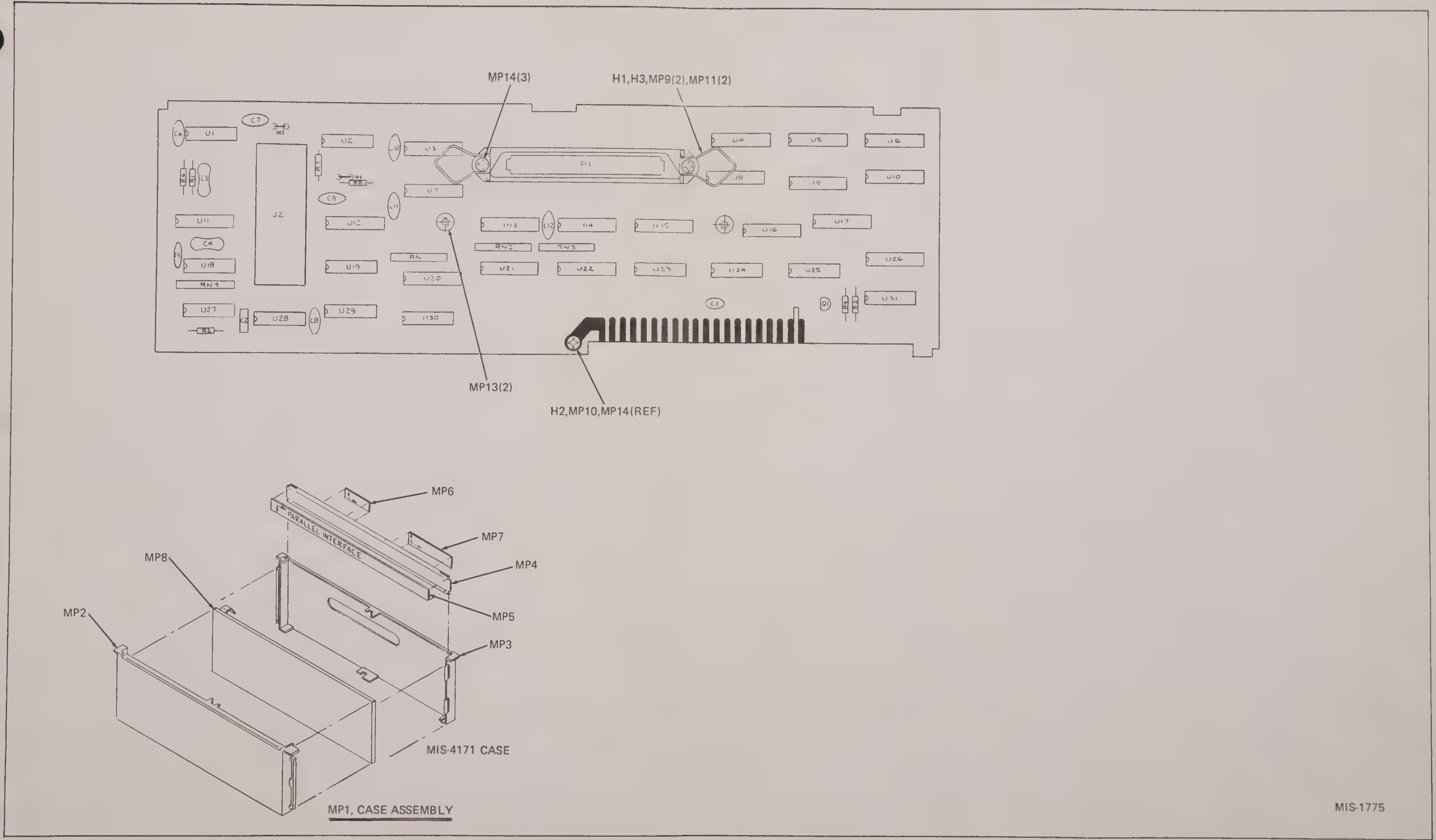
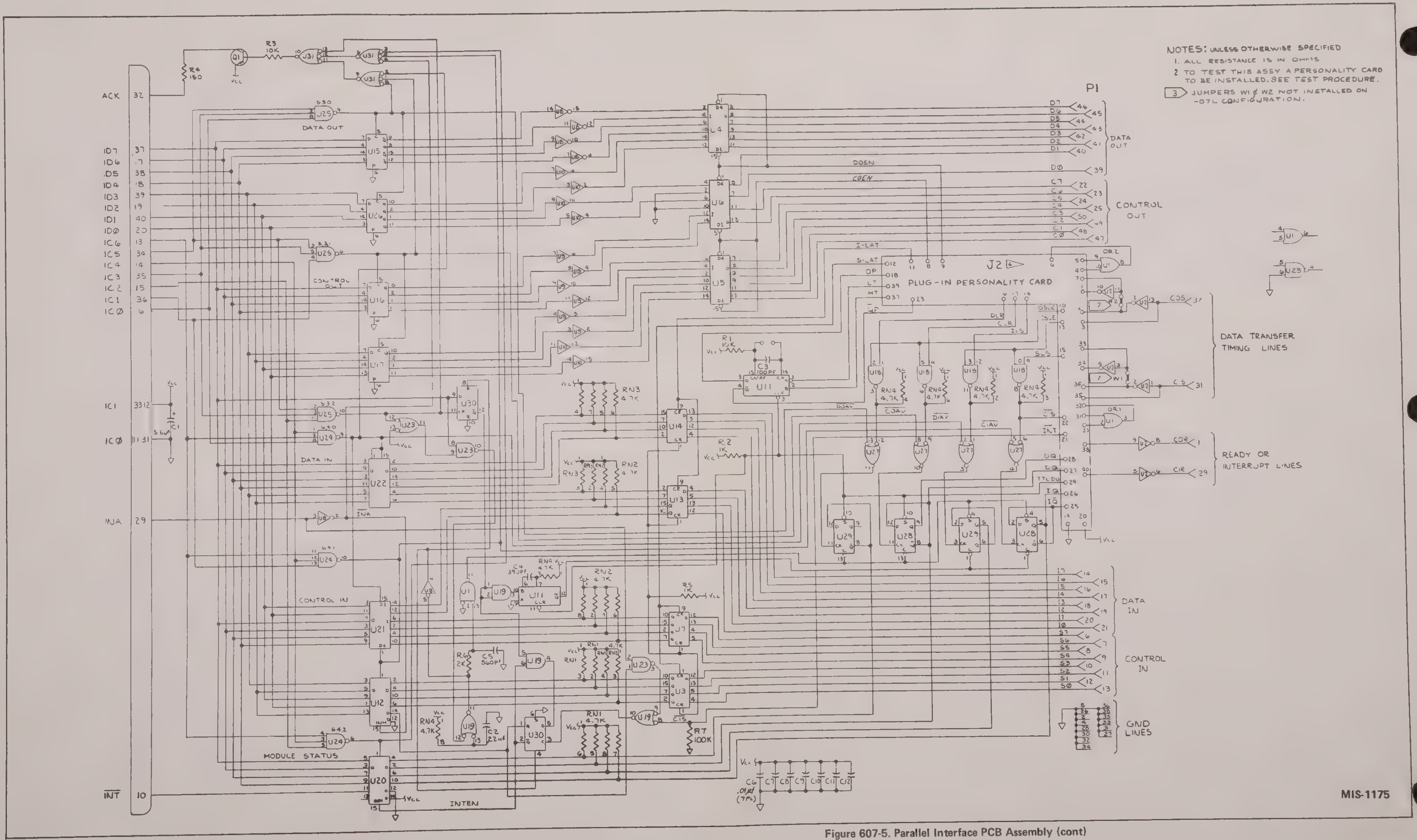

MP14(3)
H1,H3,MP9(2),MP11(2)
U1
C7
W2
C6
U2
U3
P1
U4
U5
U6
U10
C3
R7
W1
R5
U7
C9
J2
U11
U12
U13
U14
U15
U16
U17
C4
RN2
RN3
U18
RN4
U19
U20
U21
U22
U23
U24
U25
U26
C1
Q1
U31
U27
C2
U28
C8
U29
U30
MP13(2)
H2,MP10,MP14(REF)
MP6
PARALLEL INTERFACE
MP7
MP8
MP4
MP2
MP5
MP3
MIS-4171 CASE
MP1, CASE ASSEMBLY
MIS-1775

Figure 607-5. Parallel Interface PCB Assembly


ACK 32
ID7 37
ID6 7
ID5 38
ID4 8
ID3 39
ID2 19
ID1 40
ID0 20
IC6 13
IC5 34
IC4 14
IC3 35
IC2 15
IC1 36
IC0 6
IC1 33 12
IC0 11 31
INA 29
INT 10
Q1
R3 10K
R4 180
U31
DATA OUT
CONTROL OUT
DATA IN
CONTROL IN
MODULE STATUS
INTEN
U4
U5
U6
U15
U16
U17
U22
U21
U12
U20
U14
U13
U7
U3
U11
U30
DOEN
COEN
I-LAT
S-LAT
OP
LT
HT
J2
PLUG-IN PERSONALITY CARD
P1
D7
D6
D5
D4
D3
D2
D1
D0
DATA OUT
CONTROL OUT
DATA TRANSFER TIMING LINES
READY OR INTERRUPT LINES
DATA IN
CONTROL IN
GND LINES
CDS
CS
COR
CIR
W1
W2
OR1
OR2
U27
U28
U29
U18
RN1
RN2
RN3
RN4 4.7K
R1 10K
R2 1K
R5 1K
R6 2K
R7 100K
C3 100PF
C4 390PF
C5 560PF
C2 22uf
C6 C7 C8 C9 C10 C11 C12 .01uf (7PL)
Vcc
MIS-1175

NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTANCE IS IN OHMS
2 TO TEST THIS ASSY A PERSONALITY CARD TO BE INSTALLED. SEE TEST PROCEDURE.
3 JUMPERS W1 & W2 NOT INSTALLED ON -07L CONFIGURATION.

Figure 607-5. Parallel Interface PCB Assembly (cont)

Isolator -08A
(External Trigger)

608A-1. INTRODUCTION

608A-2. The Isolator module maintains the guarded nature of the analog bus by isolating the analog signal processing and converting circuitry from the digital processing, control, display, and input/output circuits. An Isolator module must be installed whenever a remote interface (option -05, -06, or -07) is used in an 8500 series DMM. The following description pertains to the Isolator -08A only. This module provides the capability for external triggering of the DMM. The 8500A DMM does not have provision for external triggering and consequently must use the -08 Isolator or the -08A without external triggering.

608A-3. INSTALLATION

608A-4. Refer to Section 4 of the Instruction Manual for general module installation procedures. The Isolator module uses slot K (which can be identified as the only module slot with connectors on both the analog and digital bus lines). Section 8 contains further information on module slot locations.

608A-5. SPECIFICATIONS

608A-6. Input

608A-7. The trigger input is factory-wired for a high level of 4.3V (minimum) and a low level of 0.7V (maximum); pulse width should be greater than 10 μs. Common will be the same as interface logic common.

608A-8. The outer connector for external triggering is at interface common. There should be no more than 10V between the outer connector and earth ground.

608A-9. Trigger Processing Time

608A-10. The time between trigger edge and first A/D conversion (not including filter timeouts or programmed delays) is:

1. Non-line synchronous mode, .8 to .9 ms
2. Line synchronous mode, 1 to 6 ms
3. High speed mode (Option -05 or -07 installed), 114 ±.5 μs

608A-11. OPERATING NOTES

608A-12. Installation of the Isolator (Option -08A) will not affect standard operation of the instrument. The External Triggering mode may, however, be activated locally from the front panel or through remote interfacing commands.

608A-13. Local Operation

608A-14. The External Triggering mode may be enabled from the DMM's front panel (Option -08A must be installed). To activate this mode, press TRIGGER. The SAMPLE LED will now stop flashing to denote that both External Triggering and Manual Triggering modes are in effect. Apply a negative going TTL level pulse to the external trigger input connector located on the rear panel. The SAMPLE LED will now flash once for each trigger received.

608A-15. The following considerations apply when External Triggering mode is in use:

1. A manual trigger attempted from the front panel will take precedence over an external trigger. If manual TRIGGER is pressed while a reading is in progress, the reading will be aborted and a new one started.
2. All other front panel switch applications will abort the reading in progress. A new reading

will not start until another trigger is received; the numeric display will not update until the new reading is complete.

608A-16. Remote Operation

608A-17. External Triggering can be enabled and controlled remotely when a remote interface (Option -05, -06, or -07) and the Isolator (Option -08A) are installed. The command characters in Table 608A-1 can be used from the remote.

608A-18. Trigger Polarity

608A-19. Either positive or negative going external triggers may be accepted by the Isolator (Option -08A); factory settings will be for negative triggers. Separate jumper wire arrangements are employed for negative and positive triggers. Refer to Figure 608A-1 for the location of jumper terminals on the Isolator PCB. To change the jumper arrangement, use the following procedure:

1. On the Digital Multimeter (8500 series), press POWER OFF and disconnect the line cord.

Table 608A-1. Remote Commands

	Ext. Trigger Commands
Q	Ext. Trigger—interrupt when ready
Q1	Ext. Trigger and Transmit Reading
Q0	Disable Ext. Trigger
	External Trigger Delay Commands
W	No Delay
W0	2.083 ms
W1	4.166 ms
W2	8.332 ms
W3	16.66 ms
W4	33.33 ms
W5	66.66 ms
W6	133.3 ms
W7	266.6 ms
W8	533.2 ms
W9	1,066s
W10	2.133s
W11	4.266s
W12	8.532s
W13	17.06s
W14	34.13s
W15	68.26s

2. Remove the Isolator module.
3. Observe Static Sensitive device precautions listed in Section 4 of the Instruction Manual. Avoid touching connector terminals on the Isolator PCB.
4. Remove the Guard Covers from the Isolator PCB using techniques outlined in Section 4 of the Instruction Manual (Module Assembly and Disassembly).
5. For negative going triggers, there will be a jumper between pin 1 and pin 4 on Schmitt Trigger U35.
6. For positive going triggers, remove the jumper between pins 1 and 4 and jumper pin 1 to 2 and 3 to 4 on U35.
7. Reassemble module, replace in Digital Multimeter.

608A-20. THEORY OF OPERATION

608A-21. The Isolator accepts parallel data and address bytes, shifts them to serial format for transfer across isolation transformers, and converts them back to parallel format. Seven address (ID) and eight data (ID) lines are used. Lines IC5 and IC6 are always low. The

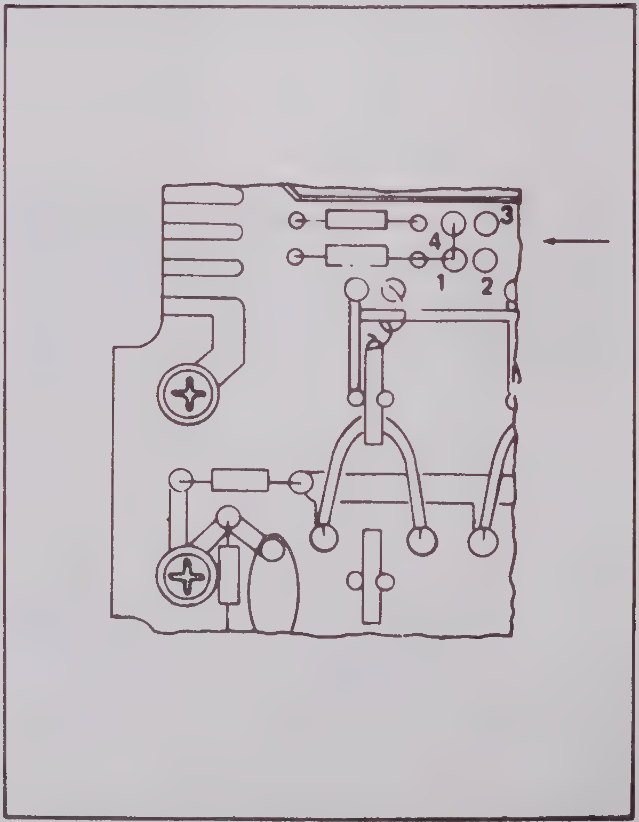


Figure 608A-1. Trigger Polarity Connections

Controller can send data to any addressed module; the A/D Converter will be the only analog module that sends data back to the Controller (bit serial data stream on ID7). Refer to the Isolator Schematic (Figure 608A-3) and the Functional Block Diagram (Figure 608A-2) for the following circuit descriptions.

NOTE

When the Isolator is Installed, Vcc and Vss in the unguarded digital bus are isolated from analog common.

608A-22. The description given in this paragraph will detail how data (ID0-ID7) and address (IC0-IC4) levels on the unguarded digital bus are loaded into shift registers (U3 and U7) in the Isolator. Inputs on address lines IC0-4 for either direct or indirect addresses are applied through inverters to shift register U7. Inputs on data lines (ID0-7) are applied to U7 (ID0, ID1) and U3 (ID2-7). A low on U14-12 will clock both address and data levels into the shift registers; the relaxation oscillator made up of U9-6 and U9-8 will be disabled by this same low during the load time. Monostable multivibrator U14-12 is clocked by a low going signal on U10-12. Two inputs to U10-12 will always be high (IC5, IC6 will always be low and are inverted). The third input will be a high from U10-8, which is enabled with any direct address on IC0-4 (IC0, 3, or 4 will have at least one high). The length of the load time will be determined by R2 and C2.

608A-23. At the end of the load time, relaxation oscillator U9-6 and U9-8 will be enabled, and data will be serially shifted out of registers U3 and U7, across isolation transformers T1 and T2, and into registers U20 and U6. Oscillator pulses from U11-10 and U11-13 clock serial data out of U3 and U7, and into U20 and U16. When this data transfer is complete, U16-11 will go high to enable address gates U22 and U26-4 and disable loading clock pulses to U20 and U16. Parallel data will then be applied through output buffers to ID0-7 on the guarded analog bus. Parallel address levels will be applied through the enabled address gates to address lines IC0-4 on the guarded analog bus.

608A-24. The clock pulse for U9-6 and U9-8 is disabled during the load period (U14-12 low). When clock pulses cease from U24-4, retriggerable monostable multivibrator U23-13 places a low on U20-9 and U16-9 to clear any previously latched data.

608A-25. An acknowledge (ACK) signal is transferred from the guarded analog bus to the unguarded digital bus by way of an isolation transformer. A low at U23-12 will enable U19-1 whenever an ACK is returned. With U19-1 high, a clock pulse from U24-4 and U24-12 is applied through U15-3, U15-6, T8 and T7. This pulse then clocks U8-2, resulting in an ACK signal out on U8-13.

608A-26. In order to obtain a data bit return on ID7, the indirect address is used in three ways. First, the address (IC1, IC2 high) is sent to the A/D Converter

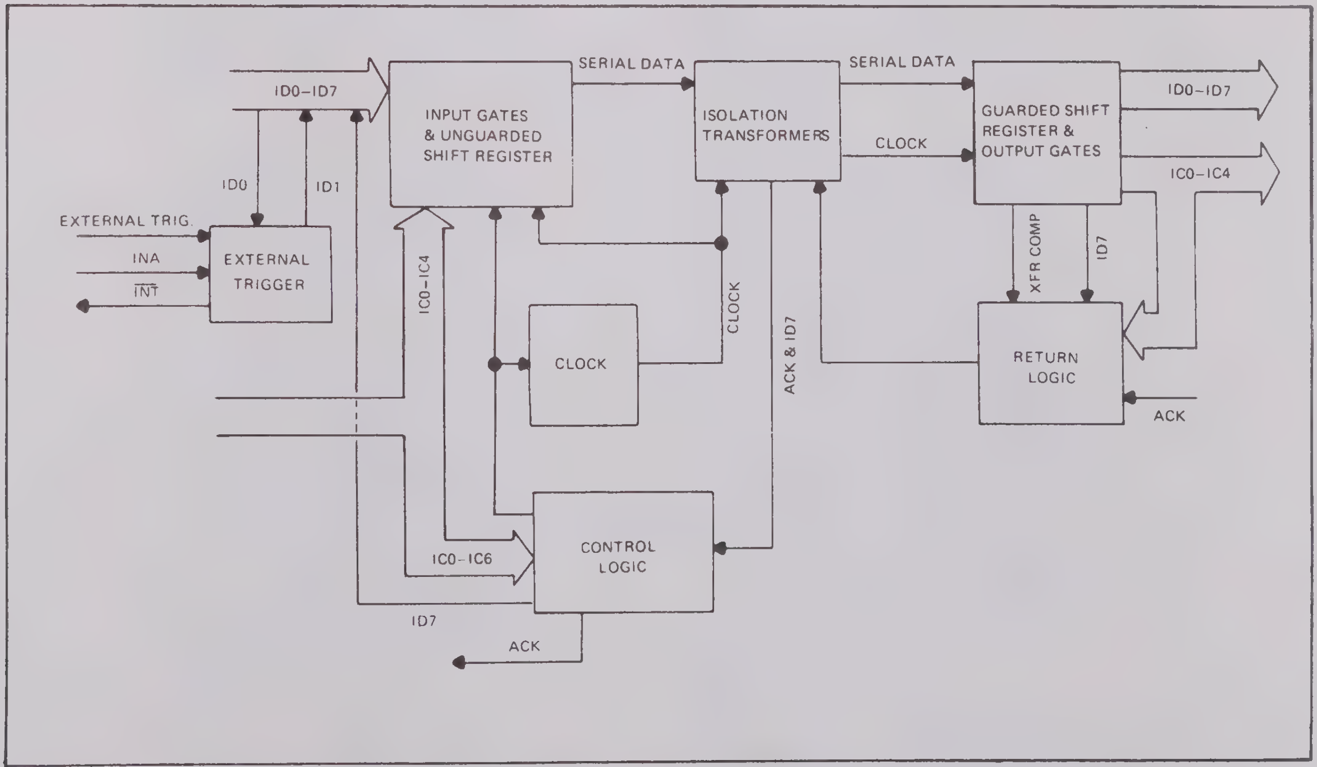


Figure 608A-2. Isolator Block Diagram

through the Isolator's shift register system. The address will also be used to enable U9-11 on the unguarded side of the Isolator. Thirdly, on the Isolator's guarded side, IC1 and IC2 high will enable address decoders U18-4 and U25-9. With U18-3 consequently high, tri-state device U21-13 is placed in the high impedance mode. A path is now enabled for ID7 levels from the guarded analog bus to be transferred back to the unguarded digital bus. For instance, with a high on U19-5, ID7 high will enable U19-4. Clock pulses from U24-4 and U19-4 high enable U15-11 and U15-8. While U9-11 enables U13-9, U8-5 clocked high places ID7 high on the unguarded digital bus.

608A-27. The following sequence of events takes place in the Isolator during external triggering. Dual D flip-flop U31 will be enabled by a low on ID0 and high at U33-9. Address lines IC4, IC5, and IC6 must all be high for U33-9 to go low. With Vcc applied to U31-5, a positive going external trigger from U35-10 will clock U31-1 high. The network of R24 and C6 will detect Vcc at power on and disable the module's interrupt capability. The high at U31-1 sets INT low and places a high at pin 12 of tri-state buffer U13. A returned high on INA then gates U13-11 high onto ID1. The controller will react to this high on ID1 by taking a reading. When data from the reading is accepted, ID0 will again go low, resetting U31 ready for the next external trigger. Triggers received prior to ID0 going low will be ignored.

608A-28. TROUBLESHOOTING

608A-29. Table 608A-2 gives a symptom analysis routine for troubleshooting the Isolator module.

608A-30. PARTS LIST

608A-31. Table 608A-3 gives a detailed parts breakdown of the Isolator (Option -08A). Refer to Section 5 of the Instruction Manual for ordering information.

Table 608A-2. Isolator Troubleshooting

SYMPTOM	POSSIBLE FAILURE
No display at Power On	IC line held low U5, U12, U35
Display Bad	IC line held high U5, U12, U35
	ID line held high or low U1, U2, U13
UNGUARDED SECTION	
Error 9 at Power On	Oscillator check U11-10 Shift Register U31-1, U7 Not transferring pulses U4, core windings ACK bad U9, U12, Q1, U6, U7, U2, U8
Option Configuration Wrong	Address lines hung
Can't Call Proper Ranges	Data lines hung U1, U2, U3
Constant Bad Reading Displayed	ID7 not returned U8, U13, core winding U12, U10, U9, U35, U6.
GUARDED SECTION	
Error 9 or Configuration Wrong	U19-10, U16-1, U23-13 (Address, Data) U25, U19, U15, U24 (ACK) U24, U23 (Address)
Can't Call Proper Ranges	U16, U21, U18
Constant Bad Reading Displayed	U18, U26, U25, U19, U15 (ID7)

Table 608A-3. Isolator PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
-08A	ISOLATOR PCB ASSEMBLY FIGURE 608A-3 (8502A-4181T)	ORDER	BY	OPTION -08A			
C1	CAP, MICA, 220 PF +/-5%, 500V	170423	72136	DM15F221J	2		
C2	CAP, MICA, 18 PF +/-5%, 500V	266585	72136	DM15C180J	1		
C3	CAP, MICA, 180 PF +/-5%, 500V	148460	72136	DM15F181J	1		
C4	CAP, MICA, 220 PF +/-5%, 500V	170423	72136	DM15F221J	REF		
C5	CAP, MICA, 68 PF +/-5%, 500V	148510	72136	DM15F680J	1		
C6	CAP, TA, 39 UF +/-20%, 6V	163915	56289	196D396X0006KA1	1		
C7	CAP, ELECT, 150 UF -10/+50%, 16V	186296	73445	ET151X016A5	1		
C8, C9	CAP, MICA, 27 PF +/-5%, 500V	177998	72136	DM15E270J	2		
C10	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	4		
C11	CAP, CER, 0.0047 UF +/-10%, 500V	106724	71590	CF-472	1		
C12, C13	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
C16	CAP, CER, 0.22 UF +/-20%, 50V	309849	71590	CW30C224K	REF		
H1	SCREW, PHP, 4-40 X 5/8	145813	73734	19027	2		
L1	INDUCTOR, COIL 6-TURN	320911	89536	320911	1		
MP1	CASE MODULE ASSY (INCLUDES MP2-MP11)	486407	89536	486407	1		1
MP2	CASE HALF, MODULE	402990	89536	402990	REF		
MP3	CASE HALF, MODULE	402990	89536	402990	REF		
MP4	COVER, MODULE, CASE	486340	89536	486340	REF		
MP5	SHIELD, COVER	437939	89536	437939	REF		
MP6	DECAL, ISOLATOR/EXT TRIGGER	477570	89536	477570	REF		
MP7	DECAL, CAUTION	454504	89536	454504	REF		
MP8	GUARD, REAR LEFT	437947	89536	437947	REF		
MP9	GUARD, REAR RIGHT	383349	89536	383349	REF		
MP10	GUARD, FRONT LEFT	487298	89536	487298	REF		
MP11	GUARD, FRONT RIGHT	487280	89536	487280	REF		
MP12	SPRING, COIL (not shown)	424465	83553	C0120-014-0380	2		
Q1	TRANSISTOR, SI, PNP	226290	04713	MPS3640	1	1	
Q2	TRANSISTOR, SI, NPN	218396	04713	2N3904	1	1	
R1	RES, DEP. CAR, 220 +/-5%, 1/4W	342626	80031	CR251-4-5P 220ET	1		
R2	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	9		
R3	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47KT	2		
R4	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P 4K7T	2		
R5	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R6	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1KT	2		
R7	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P 4K7T	REF		
R8-R13	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R14	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	2		
R15	RES, DEP. CAR, 470 +/-5%, 1/4W	343434	80031	CR251-4-5P 470ET	1		
R17	RES, DEP. CAR, 10K +/-5%, 1/4W	343426	80031	CR251-4-5P1KT	2		
R18	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	1		
R20	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	REF		
R21	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47KT	2		
R24	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
T1	INDUCTOR	437608	89536	437608	4		
T2	INDUCTOR	437590	89536	437590	4		
T3	INDUCTOR	437608	89536	437608	REF		

Table 608A-3. Isolator PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
T4	INDUCTOR	437590	89536	437590	REF		
T5	INDUCTOR	437590	89536	437590	REF		
T6	INDUCTOR	437608	89536	437608	REF		
T7	INDUCTOR	437590	89536	437590	REF		
T8	INDUCTOR	437608	89536	437608	REF		
U1	⊗IC, C-MOS, HEX BUFFER/INVERTER	381830	02735	CD4050AE	3	1	
U2	⊗IC, C-MOS, HEX BUFFER/INVERTER	381830	02735	CD4050AE	REF		
U3	IC, TTL, MSI 8 BIT SHIFT REGISTER	293118	01295	SN74165N	2	1	
U4	IC, TTL, QUAD, 2INPUT HV INTRF NAND	408021	18324	N7426A	2	1	
U5	⊗IC, C-MOS, HEX BUFFER/INVERTER	381830	02735	CD4050AE	REF		
U6	IC, TTL, POS NAND GATES, HEX INVERTERS	393058	01295	SN74LS04N	2	1	
U7	IC, TTL, MSI 8-BIT SHIFT REGISTER	293118	01295	SN74165N	REF		
U8	IC, TTL, LO PWR, SNGL/DUAL RETRIG	404186	01295	SN74LS123N	3	1	
U9	IC, TTL, QUAD 2-INPUT NAND GATE	363580	01295	SN7400SN	1	1	
U10	IC, POS NAND GATES, TRIPLE 3 INPUT	393074	01295	SN74LS10N	1	1	
U11	IC, POS NOR GATES, TOTEM POLE OUTPUTS	393041	01295	SN74LS02N	2	1	
U12	⊗IC, C-MOS, QUAD 2-INPUT NOR GATES	355172	02735	CD4001AE	1		
U13	⊗IC, C-MOS, TRI-STATE HEX NONINV BUFFERS	407759	12040	MM80C97N	2	1	
U14	IC, TTL, LO PWR, SNGL/DUAL RETRIG	404186	01295	SN74LS123N	REF		
U15	IC, TTL, QUAD, 2INPUT HV INTRF NAND	408021	18324	N7426A	REF		
U16	IC, SHIFT REGISTER, 8 BIT PARALLEL OUT	272138	01295	SN74164N	2	1	
U17	RES NETWORK, 10K +/-5%, 1/4W	355305	89536	355305	1	1	
U18	⊗IC, C-MOS, QUAD 2-INPUT AND GATES	408401	02735	CD4081B1	1	1	
U19	IC, POS NOR GATES, TOTEM POLE OUTPUTS	393041	01295	SN74LS02N	REF		
U20	IC, SHIFT REGISTER, 8 BIT PARALLEL OUT	272138	01295	SN74164N	REF		
U21	⊗IC, C-MOS, TRI-STATE HEX NONINV BUFFERS	407759	12040	MM80C97N	REF		
U22	⊗IC, C-MOS, QUAD 2-INPUT NOR GATES	355172	02735	CD4001AE	REF		
U23	IC, TTL, LO PWR, SNGL/DUAL RETRIG	404186	01295	SN74LS123N	REF		
U24	IC, TTL, POS NAND GATES, HEX INVERTERS	393058	01295	SN74LS04N	REF		
U25	⊗IC, C-MOS, TRIPLE 3-INPUT NOR GATES	355180	02735	CD4025AE	1	1	
U26	⊗IC, C-MOS, QUAD 2-INPUT NOR GATES	355172	02735	CD4001AE	1	1	
U31	⊗IC, C-MOS, DUAL "D" FLIP FLOP	340117	04713	MC14013CP	1	1	
U32	⊗IC, C-MOS, FAST QUAD 2-INPUT NAND GATE	413211	12040	34011PC/4011PC	1	1	
U33	⊗IC, C-MOS, TRIPLE 3-INPUT NAND GAE	375147	04713	MC14023CP	1	1	
U35	⊗IC, C-MOS, HEX SCHMITT TRIGGER	477810	12040	MM74C914N	1	1	

1 ORDER P/N 486407 FOR COMPLETE MODULE CASE ASSY., WITHOUT PCB ASSY.

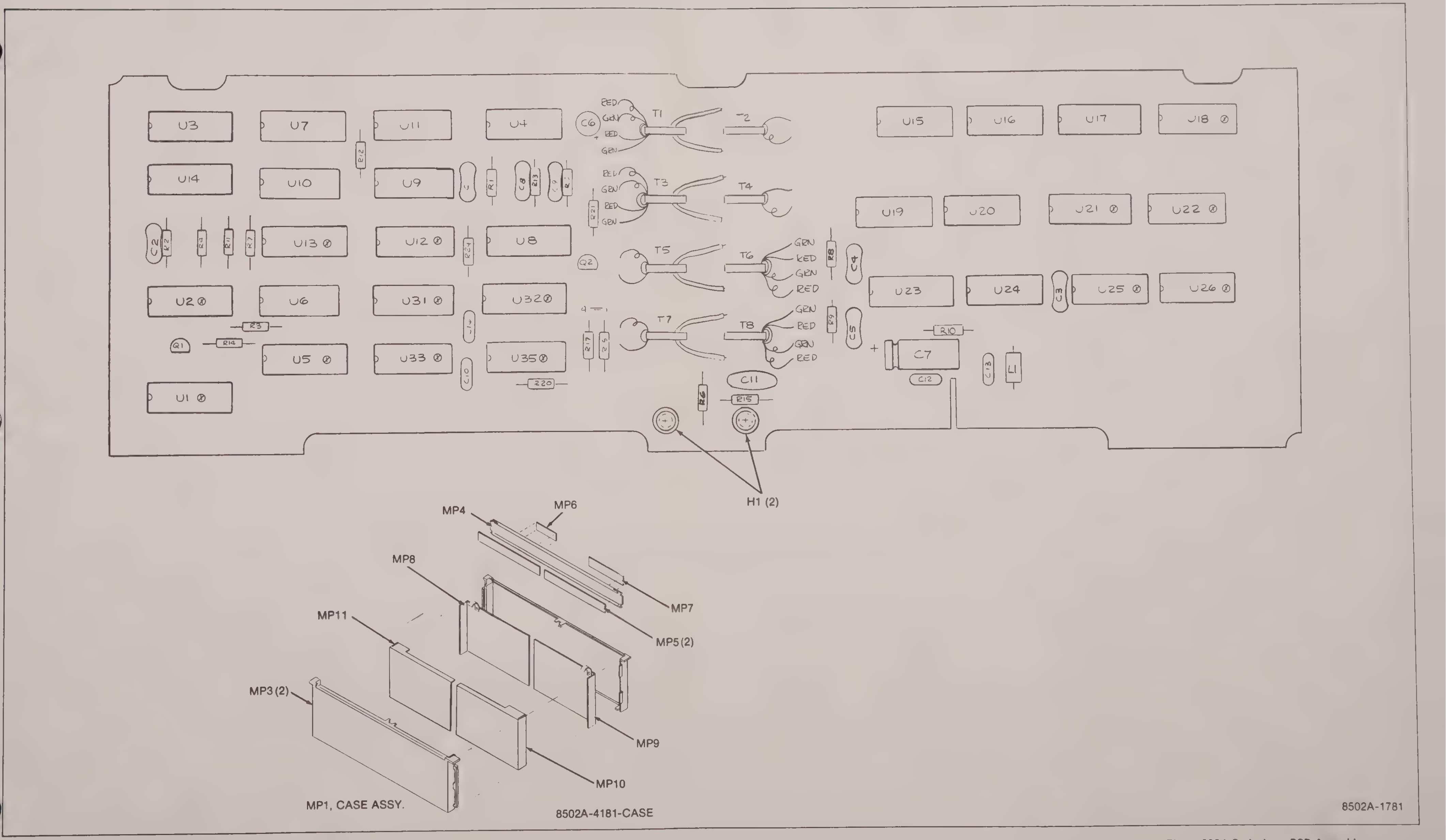
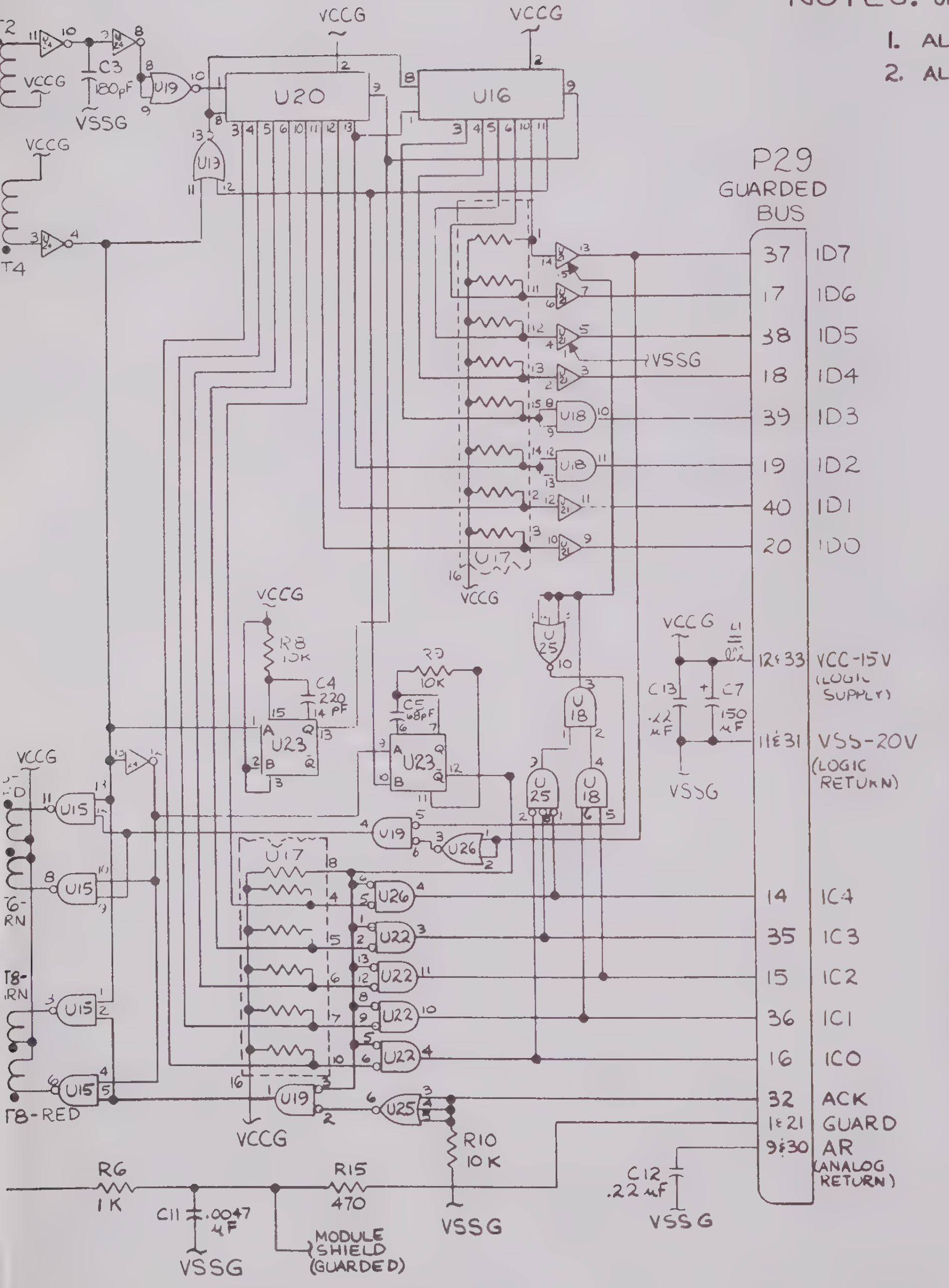

U3
U7
U11
U4
C6
T1
T2
U15
U16
U17
U18
R12
U14
U10
U9
R1
C8
R13
R
T3
T4
R21
U19
U20
U21
U22
C2
R2
R4
R11
R7
U13
U12
R24
U8
Q2
T5
T6
R8
C4
U23
U24
C3
U25
U26
U2
U6
U31
U32
T7
T8
R9
C5
R10
R3
Q1
R14
U5
U33
U35
R17
R5
C7
C13
L1
C10
R20
C11
C12
U1
R6
R15
RED
GRN
H1 (2)
MP4
MP6
MP8
MP7
MP11
MP5 (2)
MP3 (2)
MP9
MP10
MP1, CASE ASSY.
8502A-4181-CASE
8502A-1781

Figure 608A-3. Isolator PCB Assembly


VCCG
C3
180pF
VSSG
U19
U20
U16
U13
U24
T4
P29
GUARDED
BUS
37 ID7
17 ID6
38 ID5
18 ID4
39 ID3
19 ID2
40 ID1
20 ID0
VSSG
U18
U21
U17
R8
10K
C4
220
14 pF
R9
10K
C5
68pF
U23
U25
U26
U15
U22
L1
C13
.22 μF
C7
150 μF
12 & 33 VCC-15V
(LOGIC SUPPLY)
11 & 31 VSS-20V
(LOGIC RETURN)
14 IC4
35 IC3
15 IC2
36 IC1
16 IC0
32 ACK
1 & 21 GUARD
9 & 30 AR
(ANALOG RETURN)
C12
.22 μF
R6
1K
C11
.0047 μF
R15
470
R10
10 K
MODULE SHIELD (GUARDED)
T8-RED
T8-RN

NOTES: UNLESS OTHERWISE SPECIFIED:

1. ALL RESISTANCE IN OHMS.
2. ALL RESISTORS C.C. 1/4 W 5%.

UNGUARDED BUS SIDE

I.C. NO.	VCC	VSS
U32	1,2,5,6,8,9,14	7
U1	1	8
U2	1, [illegible] 4	[illegible]
U3, U7, U8, U13, U14	16	8
U4, U6, U9, U10, U11 U12 U31, U33	14	7
U5	1, 14	[illegible]
U35	1 -,5,14	7

GUARDED BUS SIDE

I.C. NO.	VCC	VSS
U15, U16, U19, U20, U22 U24, U25 U18	14	7
U21, U23	16	8
U26	8, 9, 12, 13, 14	7

8502A-1181

Figure 608A-3. Isolator PCB Assembly (cont)

Option —09A
AC/DC Converter (RMS)

609A-1. INTRODUCTION

609A-2. The AC/DC Converter (RMS) is used to provide accurate ac or ac + dc measurements without error due to waveform distortion. Measurements up to 1000 Vac in four ranges with a bandwidth of 10 Hz to 300 kHz may be made (input volt-hertz product not to exceed 2×10^7). Input impedance is 1 MΩ shunted by less than 100 pf.

609A-3. SPECIFICATIONS

609A-4. Table 609-1 lists the specifications for the true RMS Converter.

609A-5. INSTALLATION

609A-6. Refer to Section 4 of this manual under Module Installation and Removal for instructions on installing the AC/DC Converter (RMS) module. The interconnect diagram in Section 8 contains a table listing permissable and preferred slots.

609A-7. OPERATING NOTES

609A-8. Operation of the front panel controls is the same as described in Section 2. An ac voltage on a dc level may be measured by depressing both the Vdc and the Vac function switches at the same time. The reading displayed will be the rms value of the two voltages combined. External reference inputs at the rear panel must be dc voltages only. The slow filter (FILTER LED illuminated) must be selected for full accuracy below 400 Hz.

609A-9. THEORY OF OPERATION

609A-10. The function of the RMS Converter is to accept signals from either the input terminals or the optional Current Shunts module and to convert the input signal to a dc level proportional to the rms value of the input. The dc output from the RMS Converter is routed on the Guarded Bus to the Active Filter module and then to the A/D Converter. True rms conversion is mathematically obtained by averaging the squared value of the input, then taking the square root ($V_{rms} = \sqrt{\overline{V_{in}^2}}$). Limitations to the realization of this mathematical formula using operational techniques are crest factor (ratio of peak value to rms value, limited by the dynamic range of the amplifiers), frequency response, and accuracy.

609A-11. Input signals are applied to the Range Amplifier (Q1, U3) to be brought within the 1V rms range. Refer to Figure 609A-1. Before a signal can be operationally squared, it must be converted to an absolute value. Balance Amplifier (U4, Q10) performs this function by inverting and rectifying the signal from U3. Outputs from the Range Amplifier and the Balance Amplifier are applied through R33 and R31 to the summing node of the Squaring Amplifier (U5, Q11). Due to the ratio of R33 to R31, the inverted negative half-cycles from the Balance Amplifier are twice the amplitude of the negative half-cycles from the Range Amplifier. When summed, the waveform is the absolute value of the output from the Range Amplifier. The conversion to rms is performed by the Squaring Amplifier, Integrator, and Square Root Amplifier. Implementation of these functions depends on the logarithmic response of PN junctions. Since two PN junctions are used in each of two parts of a feedback loop, a double logarithmic response is generated ($2 \log X = \log X^2$). The Squaring Amplifier converts the signal to a current flowing through the emitters of two transistors, Q8A and Q12A. These two transistors are configured with two additional transistors, Q12B and Q8B, in a feedback loop which constrains the output voltage to be the square root of the integral of the square of the current flowing in Q8A and Q12A.

Table 609A-1. AC/DC Converter (RMS) Specifications

Input Characteristics

RANGE	FULL SCALE 5½ DIGITS	RESOLUTION		INPUT IMPEDANCE
		6½ DIGITS*	5½ DIGITS	
1V	2.50000V	1 μV	10 μV	1 MΩ shunted by <100 pf
10V	20.0000V	10 μV	100 μV	
100V	160.000V	100 μV	1 mV	
1000V	1000.00V	1 mV	10 mV	

*In AVG operating mode (8505A/8506A) .

Accuracy ±(% OF READING + % OF FULL SCALE)[1]

24 HOUR 23°C ±1°C				90 DAY 23°C ±5°C			
FREQUENCY*	% OF READING	% FS		FREQUENCY*	% OF READING	% FS	
		AC	AC + DC			AC	AC + DC
DC	0.075	—	0.03	DC	0.1	—	0.03
10 Hz - 20 Hz	0.75	0.04	0.06	10 Hz - 20 Hz	1.0	0.04	0.06
20 Hz - 50 Hz	0.35	0.012	0.03	20 Hz - 50 Hz	0.5	0.012	0.03
50 Hz - 10 kHz	0.075	0.012	0.03	50 Hz - 10 kHz	0.1	0.012	0.03
10 kHz - 30 kHz	0.15	0.04	0.06	10 kHz - 30 kHz	0.2	0.04	0.06
30 kHz - 50 kHz	0.2	0.1	0.12	30 kHz - 50 kHz	0.3	0.1	0.12
50 kHz - 100 kHz	0.75	0.3	0.3	50 kHz - 100 kHz	1.0	0.3	0.3
100 kHz - 300 kHz	1.5	0.5	0.5	100 kHz - 300 kHz	2.0	0.5	0.5
300 kHz - 1 MHz	2.9	1.3	1.3	300 kHz - 1 MHz	3.3	1.8	1.8

*Slow filter must be used for full accuracy below 400 Hz.

>90 DAY 23°C ±5°C
ADD TO THE 90 DAY SPECIFICATIONS PER MONTH THE FOLLOWING %:

FREQUENCY*	% OF READING	% FS	
		AC	AC + DC
DC	0.011	—	0.0033
10 Hz - 20 Hz	0.11	0.0044	0.0067
20 Hz - 50 Hz	0.056	0.0031	0.0033
50 Hz - 10 kHz	0.011	0.0031	0.0033
10 kHz - 30 kHz	0.022	0.0044	0.0067
30 kHz - 50 kHz	0.033	0.056	0.014
50 kHz - 100 kHz	0.11	0.033	0.033
100 kHz - 300 kHz	0.089	0.056	0.056
300 kHz - 1 MHz	0.044	0.033	0.033

Operating Characteristics

CREST FACTOR .... >7 at Full Scale, increasing down range by:
$7 \times \sqrt{\text{V Range / V Reading}}$

TEMPERATURE COEFFICIENT ±(% OF READING + % OF FULL SCALE) /°C*

MODE	0°C TO 18°C AND 28°C TO 50°C
AC	0.004 + 0.002
AC + DC	0.004 + 0.004

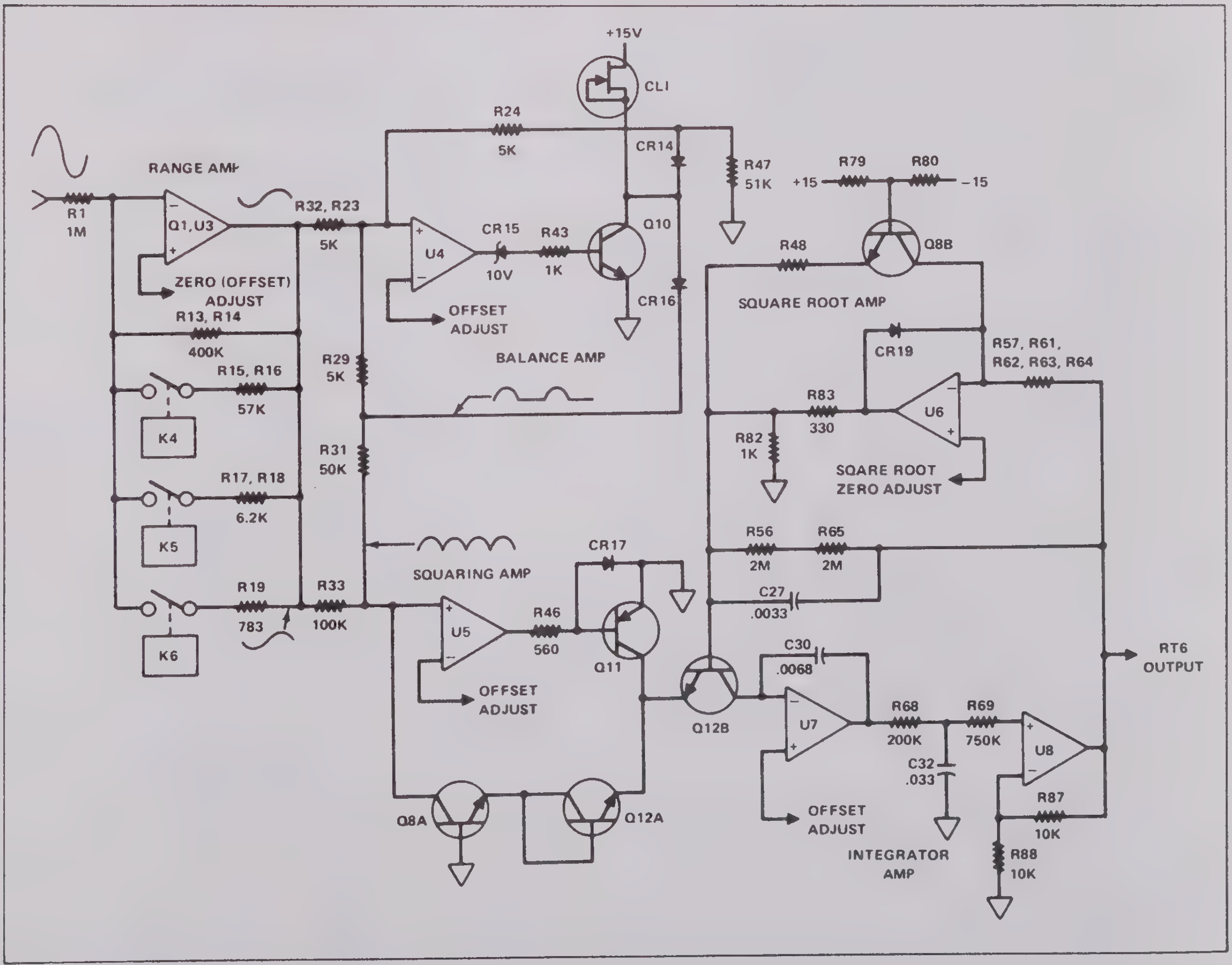
*For frequencies <10 kHz.

Table 609A-1. AC/DC Converter (RMS) Specifications (cont)

COMMON MODE REJECTION	>120 dB, dc to 60 Hz, with 100Ω in series with either lead.
RESPONSE TIME	
Analog Settling Time	100 ms with Fast Filter and 500 ms with Slow Filter to within 0.1% of in-range step change.
Digitizing Time	Same as dc volts (see Section 1).
MAXIMUM INPUT VOLTAGE	1000V rms, 1400V peak, or volts-hertz limit, whichever is less.
VOLTS-HERTZ LIMIT	1 x 10^7 for 1V and 10V ranges 2 x 10^7 for 100V and 1000V ranges

NOTES:

[1] For inputs >0.1% of range to full scale.
For inputs >500V, multiply accuracy specification by (Input voltage + 2000V) / 2000V.



+15V
CLI
R24
5K
CR14
R47
51K
RANGE AMP
R1
1M
Q1,U3
R32, R23
5K
U4
CR15
10V
R43
1K
Q10
ZERO (OFFSET) ADJUST
OFFSET ADJUST
CR16
R13, R14
400K
BALANCE AMP
R15, R16
57K
R29
5K
K4
R31
50K
R17, R18
6.2K
K5
R19
783
R33
100K
K6
SQUARING AMP
CR17
U5
R46
560
Q11
OFFSET ADJUST
Q8A
Q12A
R79
R80
+15
-15
R48
Q8B
SQUARE ROOT AMP
CR19
R57, R61, R62, R63, R64
R83
330
U6
R82
1K
SQARE ROOT ZERO ADJUST
R56
2M
R65
2M
C27
.0033
C30
.0068
Q12B
U7
R68
200K
R69
750K
U8
RT6 OUTPUT
C32
.033
OFFSET ADJUST
INTEGRATOR AMP
R87
10K
R88
10K

Figure 609A-1. AC/DC Converter (RMS)

609A-12. Circuit Description

609A-13. Refer to the schematic for the following discussion.

609A-14. RANGE AMPLIFIER

609A-15. The Range Amplifier is an inverting amplifier with gain control provided by switching feedback impedances. Feedback impedances are controlled by relays K4, K5, or K6, and consist of parallel resistors and capacitors adjusted for proper gain and frequency response. Relays K1, K2, and K7 control the input to the amplifier. K1 is energized for inputs from the input terminals. K7 is energized for inputs from the Current Shunts module. K2 is energized when selecting ac + dc measurements. Gain of the amplifier is set for a 1V rms output with a full-scale sine wave input with the exception of the 1000V range in which the full-scale output is .8V rms. Q1 and U3 provide the forward gain of the amplifier. CR6, CR7, CR21, and CR22 provide input protection. Q2 drives the guard for the summing node of the operational amplifier.

609A-16. BALANCE AMPLIFIER

609A-17. The Balance Amplifier is an inverting, unity-gain amplifier with diodes in the feedback paths to provide rectification. CL1 and Q10 are configured as a current source driven by U4. A high impedance current source is used to minimize the effects of the diodes on the gain of the amplifier. Due to the unity gain of the inverting amplifier and the ratio of R33 to R31, the negative half-cycles from the Range Amplifier are summed with positive half-cycles having twice the amplitude from the Balance Amplifier. The result is the absolute value of the output from the Range Amplifier. Q6 is used to extend the frequency response of the amplifier.

609A-18. COMPUTATION

609A-19. The Squaring Amplifier, Square Root Amplifier, and Integrator Amplifier work together to perform the rms conversion. This is accomplished by regulating the current in four transistors, Q8A, Q12A, Q8B, and Q12B, matched for temperature coefficient and response characteristics. The Squaring Amplifier sums the outputs from the Range Amplifier and the Balance Amplifier such that the current flowing through its feedback path (Q8A, Q12A) is proportional to the absolute value of the input signal. Forward gain of the amplifier is provided by U5 and Q11 with Q7 extending the frequency response.

609A-20. Q12B is configured such that the integral of its collector current is the output voltage. U7 and U8 integrate the collector current of Q12B. Q8B is configured such that its collector current is proportional to the output voltage. The current through Q8B controls the gain of U6, the Square Root Amplifier, which in turn partially controls the current flowing in Q12B. The integrating time constant of U7 and U8 is determined by R56 and R65 in parallel with C27 or C27 plus C28, depending on which filter is selected from the front panel. The proportionality constant of the converter is such that a full-scale input produces a 20V output on RT6.

609A-21. MAINTENANCE

609A-22. Performance Test

609A-23. Use the following procedure as a performance determination for the AC/DC Converter (RMS). The DC Volts Performance Test given in Section 4 should be done first to ensure proper DC accuracy.

1. Select AC Volts and Autoranging.
2. Connect the AC Calibrator output to the instrument input terminals.
3. Sequentially apply the input voltages and frequencies listed in Table 609A-2, verifying that the instrument reading is within the listed tolerance.
4. Disconnect the AC Calibrator and connect the DC Calibrator.
5. Simultaneously select DC Volts and AC Volts (both indicators illuminated).
6. Select an output from the DC Calibrator of +10.0000 Vdc.
7. The instrument display should be within 9.9840 and 10.0160.
8. Reverse the leads at the output of the DC Calibrator. The display should still read within the limits of Step 8.

Table 609A-2. Performance Test

INPUT		8500A READING	
FREQ	VOLTAGE	LOW	HIGH
10 kHz	1 V	0.99870	1.00130
50 kHz	1 V	0.99450	1.00550
10 kHz	10 V	9.9876	10.0124
50 kHz	10 V	9.9500	10.0500
10 kHz	100 V	99.881	100.119
50 kHz	100 V	99.540	100.460
10 kHz	1000 V	998.48	1001.52

609A-24. Calibration

609A-25. Before calibrating the RMS Converter, perform the DC Calibration procedure in Section 4. Remove the Calibration Memory if installed and allow a two hour warm-up. Allow adequate warm-up time for the Calibrator used, as specified in the Calibrator manual. After calibration is complete, reinstall the Calibration Memory and enter new values at the cardinal points of each range (zero may be entered).

609A-26. Use the following procedure to calibrate the AC/DC Converter (RMS). All adjustments given are on the RMS Converter and are accessible at the top of the module. R66, R55, C24 and R38 are adjustments not accessible from the top of the module which should not require adjustment unless parts have been replaced. Adjustment procedures for these adjustments are given in Troubleshooting in this section of the manual.

609A-27. Range Zero Adjustment is accomplished using the following steps:

1. Select the 10V range.
2. Simultaneously select DC Volts and AC Volts (both indicators illuminated).
3. Connect the test DVM HI to TP5, LO to TP1.
4. Short the input terminals.
5. Adjust R12, RANGE ZERO, for a reading on the test DVM of 0 ± 30 μV.
6. Remove the input short and the test DVM.

609A-28. Balance Zero Adjustment is accomplished using the following steps:

1. Apply -0.2000000 to the input terminals from the DC Calibrator. Record the reading.
2. Reverse the polarity of the input.
3. Adjust R42, BALANCE ZERO, twice as far as required to reach the reading noted.
4. Reverse polarity again. Readjust R42 until the readings are within 10 μV for either polarity without further adjustment.

609A-29. Balance Gain Adjustment is accomplished using the following steps:

1. Select the Cal mode (CAL switch down, CAL indicator illuminated). Ignore the cal digit for the remainder of this procedure.

NOTE

Entering the cal mode allows over-range inputs without the over-range indication flashing.

2. Apply -20.00000 Vdc to the input from the DC Calibrator. Note the reading.
3. Reverse the polarity.
4. Adjust R32, BALANCE GAIN, to the reading noted.
5. Reverse the polarity again. Readjust R32 until the readings with both polarities are within 10 digits without further adjustment.

609A-30. AC Zero Adjustment is accomplished using the following steps:

1. Select AC Volts, 1V range.
2. Connect the AC Calibrator to the input terminal.
3. Apply 2.5 mV AC, 500 Hz to the input.
4. Adjust R45, AC ZERO, for a reading between 0.00245 and 0.00255.

609A-31. Calibration Adjustments

609A-32. Sequentially apply the input voltages and frequencies listed in Table 609A-3, performing the adjustments as necessary to bring the reading within the stated tolerance. Select AC Volts and manual ranging for these adjustments. If in the first step R64 does not have the required range, perform the coarse calibration in the troubleshooting section. Steps 9 and 24 require a 50Ω termination at the instrument input terminals and the use of four-wire sensing with the AC Calibrator. Two test cables, each with twisted wires, may be used.

609A-33. Troubleshooting

609A-34. Troubleshooting procedures for the AC/DC Converter (RMS) follow the format used in Section 4. Table 609A-4 assures that the problem actually is in the RMS Converter. Figure 609A-2 gives a sympton analysis approach to troubleshooting, with possible failures listed in order of probability, and gives the address and data field used to set up the module. DO NOT remove or install modules with the power on.

609A-35. If Q8 or Q12 are replaced, the module must be returned to the factory (attn: PARTS) for temperature compensation. This is also the only time R38, CREST FACTOR ADJUST, should require readjustment. Do not attempt to adjust R38 as no crest factor generators are commercially available.

Table 609A-3. Calibration Adjustment

STEP	RANGE	INPUT		ADJUST/ CHECK	TOLERANCE	
		VOLTAGE	FREQUENCY		LOW	HIGH
1	1000V	500V[1]	500 Hz	R64	499.90	500.10
2	1000V	500V[1]	50 kHz	C4	499.80	500.20
3	1000V	1000V[1]	10 kHz	Wait 30 sec. Check	999.20	1000.80
4	1V	2.5V	500 Hz	R14	2.49975	2.50025
5	1V	2.5V	50 kHz	C9	2.49900	2.50100
6	10V	20V	500 Hz	R16	19.9980	20.0020
7	10V	20V	50 kHz	C11	19.9900	20.0100
8	10V	10V	1 MHz	Check (R75)[2]	9.8000	10.2000
9	1V	1V	1 MHz[3]	Check (R75)[2]	0.9800	1.02000
10	1V	2.5V	300 kHz	Check	2.48000	2.52000
11	1V	2.5V	20 kHz	Check	2.49900	2.50100
12	1V	2.5V	50 Hz[4]	Check	2.49900	2.50100
13	1V	2.5V	100 kHz	Check	2.49000	2.51000
14	1V	.25V	100 kHz	Check	0.24600	0.25400
15	1V	2.5 mV	50 kHz	Check	0.00150	0.00350
16	1V	2.5 mV	500 Hz	Check	0.00230	0.00270
17	1V	.8V	500 Hz	Check	0.79960	0.80040
18	100V	160V[1]	500 Hz	R18	159.960	160.020
19	100V	160V[1]	50 kHz	C14	159.960	160.040
20	100V	67V	300 kHz	Check	66.800	68.200
21	10V	20V	300 kHz	Check	19.7500	20.2500
22	1V	.8V	300 kHz	Check	0.78500	0.81500
23	1V	.2V	300 kHz	Check	0.18800	0.21200
24	1V	.1V	1 MHz[3]	Check	0.07000	0.13000

1. Use CAUTION, Dangerous voltage.
2. If R75 is adjusted, repeat the previous steps.
3. Terminate cable in 50Ω; use four-wire sense on Calibrator as explained in the text.
4. FILTER must be ON.

Table 609-4. AC Converter Isolation

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Do the DC Performance Test (Section4).		
2	Is DC Volts within tolerance?	3	Section 4
3	Is the Calibration Memory module installed?	4	6
4	Remove the Calibration Memory module. Is AC OK?	5	6
5	Bad Calibration Memory. Go to Section 604.		
6	Is Isolator installed?	7	10
7	Replace Isolator with Bus Interconnect/Monitor pcb.		
8	Is AC OK?	9	10
9	Bad Isolator. Go to Section 608.		
10	Remove DC Signal Conditioner. Is AC OK?	11	12
11	DC Signal Conditioner interfering with AC. The problem in the DC Signal Conditioner is one of the following: 1. Digital Logic Bad, 2. K1 or K2 shorted, 3. Q6, Q7, Q8 Bad.		
12	Install Bus Interconnect/Monitor if not already installed.		
13	Check power supply voltages as follows: VA1 = +14.24 to 15.75V VA4 = −29 to −32V VA2 = −14.25 to −15.75V Vcc = −15V Difference =4.9 VA3 = +29 to 32V Vss = −20V to 5.2		
14	Are the supply voltages OK?	15	Section 4
15	Go to Figure 609-2.		

SYMPTOM	POSSIBLE FAILURE
High reading on display with open inputs, 1000V range	C24 misadjusted, Q9, Q10, U4
High frequency (300 kHz) bad	C24 misadjusted or bad, U3
Reading not stable	U3, U4
Crest factor bad	Q8, Q12
AC breaks down (overload source above 500V)	K7
AC out of tolerance in slow filter mode	Q13 and Q14, Q16 and Q17
One range bad	Digital Logic Range Relays, CR14, CR16
All ranges bad	U3, Q1, U5, Q7, U7, U8, K8, K1
Excessive noise	U3, Q2
Display blanks	U1, U10

The largest single failure items tend to be relays and electrolytic capacitors

Note: If Q8 or Q12 is replaced, the module should be returned to the factory (Attn. Parts) for temperature compensation and adjustment of R38.

Address IC 0, 2, 4 high

IDO =0, ID1 = 0 —DC Coupled AC
IDO = 1, ID1 =0 —AC Volts
DIO = 0, ID1 = 1 —RT1 input for AC Current
ID2 =0 —Filter On
ID3 =0 —10V range
ID4 =0 —100V range
ID5 =0 —1000V range
ID3 through ID5 = 1—1V range

Figure 609-2. Symptom Analysis

609A-36. Preliminary Calibration

609A-37. If other parts are replaced, it may be necessary to make the following adjustments before continuing with the calibration procedure. To assure proper functioning of the module the following procedure should be completed. Many of the adjustments must be performed again in the final calibration procedure. Always perform final calibration from the beginning of the procedure. Select the cal mode by placing the CAL switch in the down position. Ignore the cal digit for this procedure. Some of these adjustments are not accessible from the top of the module. Center all adjustments before beginning calibration except for R38, C24, and R64. R64 should be set fully counterclockwise. R38 should NOT be changed.

CAUTION

When high voltages are applied to the input terminals and the module is not enclosed in the case, hazardous voltages are present on the board. Use an insulated tool for making adjustments while keeping hands away from the PCB.

1. Select AC Volts and the 1V range (manually) and short the input terminals.
2. Short TP3 and TP4 to the metal divider on the board.
3. Connect the test DVM HI to TP2 and LO to TP1.
4. Adjust R66, INTEGRATOR ZERO, for 0V ±100 μV.
5. Remove the short from TP3.
6. Add a jumper from the bottom of R57 (junction with R61) to a jumper added across R48.
7. Connect the test DVM HI to TP3.
8. Adjust R55, SQUARE ROOT ZERO, for OV ±100 μV.
9. Remove the short from TP4 and the jumper from R48.
10. Simultaneously select AC Volts and DC Volts; manually select the 10V range.
11. Connect the test DVM HI to TP5.
12. Adjust R12. RANGE ZERO, for 0V ± 30 μV.
13. Disconnect the test DVM and remove the short from the input terminals.
14. Center R45, AC ZERO, and apply -0.2V from the DC Calibrator to the input terminals. Note the reading on the display.
15. Reverse the polarity of the input and adjust R42, BALANCE ZERO, twice as far as required to reach the reading noted.
16. Reverse the polarity again and readjust R42 until the readings obtained with both polarities are within 10 digits without further adjustment.
17. Apply -20V DC to the input and note the reading.
18. Reverse the input polarity and adjust R32, BALANCE GAIN, for the same reading as noted in the last step ±5 digits.
19. Apply -0.02V DC and adjust R45, AC Zero, for a reading of 0.0200 ±5 digits.
20. Disconnect the DC Calibrator and connect the AC Calibrator.
21. Select AC Volts and the 1000V range.
22. Set R64 fully counterclockwise.
23. Apply 500V @ 500 Hz to the input from the AC Calibrator.
24. Note the reading and clip links according to Table 609A-5. Link 1 is across R61, link 2 is across R62, and link 3 is across R63.
25. Adjust R64, 1000V LOW FREQ, ADJUST, for a reading of 500.000V ±20 digits.
26. Change the frequency to 50 kHz and adjust C4, 1000V HIGH FREQ ADJUST, for 500.000V ±20 digits.
27. Apply 2.5V @ 500 Hz to the input and manually select the 1V range.
28. Adjust R14, 1V LF, for 2.50000 ±10 digits.
29. Change the input frequency to 500 kHz and adjust C9, 1V HF-1, for 2.50000 ±100 digits.
30. Change the input frequency to 500 kHz and adjust C24, 1V HF-2, to bring the reading toward 2.5V. Adjusting C24 will require re-adjusting C9. Alternately adjust C9 as in step 29, than C24 @ 500 kHz until a reading of 2.50000V ±3000 digits is obtained.

NOTE

C9 has approximately twice the effect at 500 kHz as at 50 kHz. If C24 hasn't enough range, adjust R75, 1 MHz. Turn it CW to raise the reading or CCW to lower the reading (½ turn is about 3000 digits).

31. Check the stability by selecting the 1000V range and applying 1000V @ 10 kHz. The reading should be 1000.00 ±80 digits. Wait thirty seconds. If the reading is out of tolerance, with caution and an insulated tool, adjust C24 slightly beyond the point where a stable reading is displayed. Recheck steps 29 and 30.
32. Apply 20V @ 500 Hz and select the 10V range.
33. Adjust R16, 10V LF, for a reading of 20.0000 ±20 digits.
34. Change the frequency to 50 kHz and adjust C11, 10V HF, for 20.0000 ±100 digits.
35. Apply 10V @ 1 MHz using four-wire sensing (without the 50Ω termination).
36. Adjust R75, 1 MHz, for a reading of 10.0000 ±100 digits.
37. Apply 1V @ 1 MHz using four-wire sensing with the 50Ω termination at the input terminals. Manually select the 1V range.
38. Initially note the reading without adjusting R75. If this reading is not 1.00000V ±.036V, adjust C24 until the reading is within ±.036V and note this reading. Adjust R75 until the reading is halfway between the noted reading and 1.00000V. This final reading, then, should be 1.00000V ±.018V.
39. Apply 500V @ 50 kHz. The reading should be 500.00 ±20 digits (adjust C4 if necessary).
40. Apply 2.5V @ 500 kHz and check reading for 2.50000 ±.03V. Adjust C24 if necessary to bring the reading within the specification.
41. If C24 was adjusted in Step 40, check the stability by applying 1000V @ 10 kHz. The reading should be stable at 1000.00 ±.8V. Readjust C24 and repeat Step 40 if the reading is unstable.
42. Apply 2.5V @ 50 kHz. Adjust C9 if necessary for a reading of 2.50000 ±.001V.
43. Apply 20V @ 50 kHz and adjust C11 if necessary for a reading of 20.0000 ±.01V.
44. Apply 10V @ 1 MHz using a four-wire cable. The reading should be 10.0000 ±.02V.
45. Apply 1V @ 1 MHz using a four-wire cable with a 50Ω termination. The reading should be 1.00000 ±.02V.
46. If Steps 44 or 45 are out of tolerance repeat Steps 36 through 45.
47. Select the 100V range and apply 160V @ 500 Hz. Verify that R18, 100V LF, will adjust the reading to 160.000V ± 50 digits.
48. Check the output ripple by turning the filter off and applying 2.5V @ 200 Hz from a lab oscillator on the 1V range and adjust the oscillator output for a reading of 2.50000V ± 1000 digits. Connect the oscilloscope HI to TP2, LO to shield. The ripple should be less than 20 mV P-P.
49. Change the frequency to 20 Hz and turn the filter on. Readjust the voltage as in step 44 The ripple should be less than 80 mV P-P.
50. Perform the Calibration procedure (Paragraph 609A-24).

Table 609A-5. High Voltage, Low Frequency Coarse Adjust

Reading	Links Previously Clipped	Clip Links	Replace Links
500 - 495.5 N/A (Pot R64 should adjust properly)		None	None
495.5 - 491.1	1	2	1
	2	1	None
	1 & 2	3	1 & 2
	3	1	None
	1 & 3	2	1
	2 & 3	1	None
500 - 504.5	1	None	1
	2	1	2
	1 & 2	None	1
	3	1 & 2	3
	1 & 3	None	1
	2 & 3	1	3
	1, 2, & 3	None	1

609A-38. PARTS LIST

609A-39. Table 609A-6 gives a parts breakdown for the AC/DC Converter (RMS). Refer to Section 5 for ordering information.

CAUTION

Indicated devices are subject to damage by static discharge.

Table 609A-6. RMS Converter PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
-09A⊗	RMS CONVERTER PCB ASSEMBLY FIGURE 609A-3 (MIS-4103T)	ORDER	BY	OPTION -09A			
C1	CAP, MYLAR, 0.22 UF +/-20%, 1200V	268904	89536	268904	1		
C2	CAP, PORC, 1.5 PF +/-0.25 PF, 1.7V ACK	461004	95275	VY10CA1R5CA	1		
C3	CAP, MICA, 220 PF +/-5%, 500V	170423	72136	DM15F221J	1		
C4	CAP, VAR, 0.25-1.5 PF, 2000V	218206	72982	530-000	2		
C7	CAP, MYLAR, 0.1 UF +/-10%, 100V	393439	73445	C280MAH/A100K	2		
C8	CAP, PORC, 5.6 PF +/-0.25 PF, 100V	460568	95275	VY10CA5R6CA	1		
C9	CAP, VAR, 0.25-1.5 PF, 2000V	218206	72982	530-000	REF		
C10	CAP, MICA, 43 PF +/-1%, 500V	277202	72136	DM15E430F	1		
C11	CAP, VAR, 0.8-10. PF, 250V	229930	91293	JM2951	1		
C12	CAP, POLY FILM, 0.047 UF +/-10%, 250V	162008	73445	C280MAE/A47K	1		
C13	CAP, MICA, 390 PF +/-1%, 500V	355339	72136	DM15F391F	1		
C14	CAP, VAR, 9-35 PF, 350V	289637	72982	538-006D9-35	1		
C15	CAP, MICA, 3600 PF +/-2%, 500V	176644	72136	DM19F362G	1		
C16	CAP, MICA, 27 PF +/-5%, 500V	177998	72136	DM15F270J	5		
C17	CAP, MICA, 8 PF +/-10%, 500V	216986	72136	DM15C080K	1		
C18	CAP, MICA, 15 PF +/-5%, 500V	148569	72136	DM15C150J	3		
C19	CAP, MICA, 1000 PF +/-5%, 500V	148387	72136	DM19F102J	2		
C20	CAP, MICA, 27 PF +/-5%, 500V	177998	72136	DM15F270J	REF		
C21	CAP, MICA, 2 PF +/-0.5%, 500V	175208	72136	DM15C020E	1		
C22	CAP, MICA, 1000 PF +/-5%, 500V	148387	72136	DM19F102J	REF		
C23	CAP, TA, ELECT, 15 UF +/-10%, 20V	153056	56289	150D156X0020B2	4		
C24	CAP, VAR, 1.7-10 PF, 250V	321109	56289	GKB10000	1		
C25	CAP, MICA, 390 PF +/-5%, 500V	148437	72136	DM15F391J	1		
C26	CAP, MICA, 27 PF +/-5%, 500V	177998	72136	DM15F270J	REF		
C27	CAP, MYLAR, 0.0033 UF +/-10%, 50V	402867	06001	75F1R5A-333	2		
C28	CAP, POLY FILM, 0.01 UF +/-10%, 400V	402818	73445	C280MAF/A10K	1		
C29	CAP, MYLAR, 0.022 UF +/-10%, 250V	234484	73445	C280MAE/A22K	2		
C30	CAP, MYLAR, 0.0068 UF +/-20%, 200V	106070	56289	192P68202	1		
C31	CAP, MICA, 27 PF +/-5%, 500V	177998	72136	DM15F270J	REF		
C32	CAP, MYLAR, 0.033 UF +/-10%, 250V	234492	73445	C280MAE/A33K	2		
C33	CAP, MYLAR, 0.0047 UF +/-10%, 50V	260844	06001	75F1R5A347	1		
C34	CAP, MYLAR, 0.1 UF +/-10%, 100V	393439	73445	C280MAH/A100K	REF		
C35	CAP, MYLAR, 0.033 UF +/-10%, 250V	234492	73445	C280MAE/A33K	REF		
C36, C37	CAP, TA, ELECT, 15 UF +/-10%, 20V	153056	56289	150D156X0020B2	REF		
C38	CAP, MICA, 4 PF +/-0.5%, 500V	190397	72136	DM15C040E	2		
C39	CAP, TA, ELECT, 15 UF +/-10%, 20V	153056	56289	150D156X0020B2	REF		
C40	CAP, MICA, 15 PF +/-5%, 500V	148569	72136	DM15C150J	REF		
C41	CAP, MYLAR, 0.022 UF +/-10%, 250V	234484	73445	C280MAE/A22K	REF		
C42	CAP, MYLAR, 0.0033 UF +/-10%, 50V	402867	06001	75F1R5A-333	REF		
C43	CAP, TA, 6.8 UF +/-20%, 35V	363713	56289	196D68X0035HA1	1		
C44	CAP, MICA, 4 PF +/-0.5%, 500V	190397	72136	DM15C040E	REF		
C45	CAP, MICA, 27 PF +/-5%, 500V	177998	72136	DM15F270J	REF		
C46	CAP, MICA, 15 PF +/-5%, 500V	148569	72136	DM15C150J	REF		
C47	CAP, MYLAR, 0.001 UF +/-10%, 200V	159582	56289	192P10292	1	1	
CL1	DIODE, FET, CURRENT REGULATOR	429373	89536	429373	1		
CR2-CR5	DIODE, SI, HI-SPEED, SWITCHING	203323	07910	1N4448	8	2	
CR6, CR7	DIODE, SI, LO-CAP, LO-LEAKAGE	375907	07263	FD7222	4	1	

Table 609A-6. RMS Converter PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
CR8	DIODE, SI, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR9	DIODE, SI, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR10	DIODE, SI, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR11	DIODE, ZENER	246611	07910	1N961B	4	1	
CR14	DIODE, SI, SM SIG	313247	28484	HP5082-6264	2	1	
CR15	DIODE, ZENER	246611	07910	1N961B	REF		
CR16	DIODE, SI, SM SIG	313247	28484	HP5082-6264	REF		
CR17	DIODE, SI, HI-SPEED, SWITCHING	203323	07910	1N4448	REF		
CR18	DIODE, ZENER	246611	07910	1N961B	REF		
CR19	DIODE, SI, 75 MA, 90 PIV	260554	07910	CD55105	1	1	
CR20	DIODE, SI, LO-CAP, LO-LEAKAGE	375907	07263	FD7222	REF		
CR21	DIODE, ZENER	260695	07910	1N754A	2	1	
CR22	DIODE, ZENER	260695	07910	1N754A	REF		
CR24	DIODE, ZENER	246611	07910	1N961B	REF		
CR25	DIODE, SI, LO-CAP, LO-LEAKAGE	375907	07263	FD7222	REF		
H1	SCREW, RH FILISTER, 6-32 X 1/2 (NOT SHOWN)	115006	89536	115006	3		
H2	SCREW, RHP, 4-40 X 3/8	256164	89536	256164	1		
K1	RELAY ASSY						
	COIL, REED RELAY	272070	71707	UD-6-P	2		
	SWITCH, DRY REED	284091	95348	MR138	5		
	SWITCH, DRY REED	284091	95348	MR138	REF		
	FOIL WRAP	313833	89536	313833	5		
	FOIL WRAP	313833	89536	313833	REF		
K2	RELAY ASSY						
	COIL, REED RELAY	269019	71707	U-6-P	1		
	SWITCH, DRY REED	284091	95348	MR138	REF		
	FOIL WRAP	313833	89536	313833	REF		
K4	RELAY, DRY REED	357566	71707	UF40069	4		
K5	RELAY, DRY REED	357566	71707	UF40069	REF		
K6	RELAY, DRY REED	357566	71707	UF40069	REF		
K7	RELAY ASSY						
	COIL, REED RELAY	272070	71707	UD-6-P	REF		
	SWITCH, DRY REED	284091	95348	MR138	REF		
	SWITCH, DRY REED	284091	95348	MR138	REF		
	FOIL WRAP	313833	89536	313833	REF		
	FOIL WRAP	313833	89536	313833	REF		
K8	RELAY, DRY REED	357566	71707	UF40069	REF		
MP1	CASE MODULE ASSY (INCLUDES MP2-MP9)	425231	89536	425231	1		1
MP2	CASE HALF	402990	89536	402990	2		
MP3	CASE HALF	402990	89536	402990	REF		
MP4	COVER, MODULE CASE	402974	89536	402974	REF		
MP5	SHIELD, COVER	468462	89536	468462	REF		
MP6	DECAL, AC/DC CONVERTER (RMS)	413401	89536	413401	REF		
MP7	DECAL CAUTION	454504	89536	454504	REF		
MP8	GUARD, REAR	383364	89536	383364	REF		
MP9	GUARD, FRONT	383356	89536	383356	REF		
MP10	FEED-THRU, TEFLON	281865	12615	SL-841-777	4		
MP11	HEATSINK	347740	05820	260-18D	1		
MP12	INSULATOR, SHIELD (not shown)	426932	89536	426932	1		

Table 609A-6. RMS Converter PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
MP13	SHIELD	416214	89536	416214	1		
	(not shown)				REF		
MP14	SHIELD, INPUT	468470	89536	468470	1		
	(not shown)						
MP15	SOCKET	343285	00779	2-331272-6	7		
	(not shown)				REF		
MP16	SPRING, COIL	424465	83553	C0120-014-0380	1		
MP17	STAND-OFF, TEFLON	275719	15849	1497B	5		
	(not shown)				REF		
MP18	STANDOFF	423806	89536	423806	3		
MP19	SPACER, STANDOFF, 4-40	334604	89536	334604	1		
MP20	TERMINAL, TEST POINT	179283	89536	179283	4		
	(not shown)						
Q1	XSTR, FET, DUAL, N-CHANNEL	287623	89536	287623	1	1	
Q2	XSTR, FET, N-CHANNEL	343103	89536	343103	3	1	
Q4	XSTR, SI, NPN	218396	04713	2N3904	4	1	
Q6, Q7	XSTR, FET, N-CHANNEL	343103	89536	343103	REF		
Q8	XSTR, MATCHED SET	504191	89536	504191	1	1	2
	(Q8 & Q12)						
Q10	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q11	XSTR, SI, PNP	195974	04713	2N3906	1	1	
Q12	XSTR, (part of Q8 set)						
Q13	XSTR, FET, N-CHANNEL	288324	89536	288324	3	1	
Q14	XSTR, FET, N-CHANNEL	393314	89536	393314	1	1	
Q15	XSTR, SI, PNP	218388	07236	2N3645	1	1	
Q16, Q17	XSTR, FET, N-CHANNEL	288324	89536	288324	REF		
Q18, Q19	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q20	XSTR, SI, PNP	226290	04713	MPS3640	1	1	
R1	RES, MTL. FILM, 1M +/-0.1%, 1W	340265	89536	340265	1		
R2	RES, MTL. FILM, 16.9K +/-1%, 1/8W	267146	91637	CMF551692F	1		
R3	RES, DEP. CAR, 200 +/-5%, 1/4W	193482	80031	CR251-4-5P200E	1		
R4	THERMISTOR, TEMP SENS, NEG TC	501304	89536	501304	1		
R5	RES, DEP. CAR, 120K +/-5%, 1/4W	441386	80031	CR251-4-5P120K	2		
R6, R7	RES, MTL. FILM, 50K +/-0.1%, 1/8W	340257	91637	CMF555002B	3		
R8	RES, DEP. CAR, 120K +/-5%, 1/4W	441386	80031	CR251-4-5P120K	REF		
R9	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	5		
R10	RES, DEP. CAR, 470 +/-5%, 1/4W	343434	80031	CR251-4-5P470E	1		
R11	RES, DEP. CAR, 12K +/-5%, 1/4W	348847	80031	CR251-4-5P12K	1		
R12	RES, VAR, CERMET, 1M +/-10%, 1/2W	334722	89536	334722	3		
R13	RES, MTL. FILM, 399.0K +/-0.1%, 1/8W	417212	91637	CMF553993B	1		
R14	RES, VAR, CERMET, 5K +/-10%, 1/2W	288282	89536	288282	1		
R15	RES, MTL. FILM, 56.89K +/-0.1%, 1/8W	417220	89536	417220	1		
R16	RES, VAR, CERMET, 500 +/-10%, 1/2W	291120	89536	291120	1		
R17	RES, MTL. FILM, 6324 +/-0.1%, 1/8W	417238	89536	417238	1		
R18	RES, VAR, CERMET, 50 +/-10%, 1/2W	285122	89536	285100	2		
R19	RES, MTL. FILM, 782.8 +/-0.1%, 1/8W	417246	89536	417246	1		
R20	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7	2		
R21	RES, DEP. CAR, 100 +/-5%, 1/4W	348771	80031	CR251-4-5P100E	1		
R22	RES, DEP. CAR, 330 +/-5%, 1/4W	368720	80031	CR251-4-5P330E	3		

Table 609A-6. RMS Converter PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
R23	RES, MTL. FILM, 4.975K +/-0.1%, 1/8W	340232	89536	340232	1		
R24	RES, DEP. CAR, 5.1K +/-5%, 1/4W	368712	80031	CR251-4-5P5K1	1		
R25	RES, DEP. CAR, 2K +/-5%, 1/4W	441469	80031	CR251-4-5P2K	1		
R26	RES, DEP. CAR, 3.9K +/-5%, 1/4W	342600	80031	CR251-4-5P3K9	1		
R27	RES, MTL. FILM, 1M +/-1%, 1/8W	268797	91637	CMF551004F	2		
R28	RES, MTL. FILM, 121 +/-1%, 1/8W	343160	91637	CMF551210F	1		
R29	RES, MTL. FILM, 5K +/-0.1%, 1/8W	340240	91637	CMF555001B	1		
R30	RES, DEP. CAR, 5.6K +/-5%, 1/4W	442350	80031	CR251-4-5P5K6	3		
R31	RES, MTL. FILM, 50K +/-0.1%, 1/8W	340257	91637	CMF555002B	REF		
R32	RES, VAR, CERMET, 50 +/-10%, 1/2W	285122	89536	285100	REF		
R33	RES, MTL. FILM, 100K +/-0.1%, 1/8W	340166	91637	CMF551003B	1		
R34	RES, MTL. FILM, 35.7K +/-1%, 1/8W	288480	91637	CMF553572F	1		
R35	RES, DEP. CAR, 620K +/-5%, 1/4W	442509	80031	CR251-4-5P620K	1		
R36	RES, DEP. CAR, 82 +/-5%, 1/4W	442277	80031	CR251-4-5P82E	1		
R37	RES, DEP. CAR, 5.6K +/-5%, 1/4W	442350	80031	CR251-4-5P5K6	REF		
R38	RES, VAR, CERMET, 3 +/-25%, 1/2W	347963	32997	3329H-J81-3R0	1		
R39	RES, SELECTED						2
R40	RES, DEP. CAR, 5.6K +/-5%, 1/4W	442350	80031	CR251-4-5P5K6	REF		
R42	RES, VAR, CERMET, 1M +/-10%, 1/2W	334722	89536	334722	REF		
R43	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	3		
R44	RES, DEP. CAR, 9.1K +/-5%, 1/4W	441691	80031	CR251-4-5P9K1	1		
R45	RES, VAR, CERMET, 1M +/-10%, 1/2W	334722	89536	334722	REF		
R46	RES, DEP. CAR, 560 +/-5%, 1/4W	385948	80031	CR251-4-5P560E	3		
R47	RES, DEP. CAR, 51K +/-5%, 1/4W	376434	80031	CR251-4-5P51K	1		
R48	RES, SELECTED						2
R49	RES, DEP. CAR, 330 +/-5%, 1/4W	368720	80031	CR251-4-5P330E	REF		
R50	RES, CAR. DEP, 2.7 +/-5%, 1/4W	442061	80031	CR251-4-5P2E7	1		
R51	RES, DEP. CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47K	1		
R52	RES, MTL. FILM, 4.02M +/-1%, 1/4W	417253	91637	CMF604024F	1		
R53	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R54	RES, DEP. CAR, 560 +/-5%, 1/4W	385948	80031	CR251-4-5P560E	REF		
R55	RES, VAR, CERMET, 1M +/-10%, 1/2W	276691	89536	276691	2		
R56	RES, MTL. FILM, 2M +/-0.25%, 1/2W	327502	91637	CMF652004C	2		
R57	RES, MTL. FILM, 930K +/-0.25%, 1/4W	417345	91637	CMF609303C	1		
R58	RES, MTL. FILM, 1M +/-1%, 1/8W	268797	91637	CMF551004F	REF		
R59	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R60	RES, DEP. CAR, 560 +/-5%, 1/4W	385948	80031	CR251-4-5P560E	REF		
R61	RES, MTL. FILM, 17.4K +/-1%, 1/8W	236802	91637	CMF551742F	1		
R62	RES, MTL. FIL, 34K +/-1%, 1/8W	261602	91637	CMF553402F	1		
R63	RES, MTL. FILM, 68.1K +/-1%, 1/8W	236828	91637	CMF556812F	1		
R64	RES, VAR, CERMET, 20K +/-10%, 1.2W	291609	89536	291609	1		
R65	RES, MTL. FILM, 2M +/-0.25%, 1/2W	327502	91637	CMF652004C	REF		
R66	RES, VAR, CERMET, 1M +/-10%, 1/2W	276691	89536	276691	REF		
R67	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R68	RES, DEP. CAR, 200K +/-5%, 1/4W	441485	80031	CR251-4-5P200K	1		
R69	RES, DEP. CAR, 750K +/-5%, 1/4W	442525	80031	CR251-4-5P750K	1		
R70	RES, DEP. CAR, 1M +/-5%, 1/4W	348987	80031	CR251-4-5P1M	REF		
R71	RES, DEP. CAR, 470K +/-5%, 1/4W	342634	80031	CR251-4-5P470K	1		
R72	RES, DEP. CAR, 22K +/-5%, 1/4W	348870	80031	CR251-4-5P22K	1		
R73	RES, DEP. CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100K	1		

Table 609A-6. RMS Converter PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	NOTE
R74	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	2		
R75	RES, VAR, CERMET, 10K +/-10%, 1/2W	285171	89536	285171	1		
R76	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R77	RES, MTL. FILM, 23.2K +/-1%, 1/8W	291351	91637	CMF552322F	1		
R78	RES, MTL. FILM, 10 +/-1%, 1/8W	268789	91637	CMF55A100F	1		
R79	RES, SELECTED						2
R80	RES, SELECTED						2
R81	RES, THERMISTOR, TEMP SENSITIVE	104596	73168	JA41J1	1		
R82	RES, DEP. CAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1K	REF		
R83	RES, DEP. CAR, 330 +/-5%, 1/4W	368720	80031	CR251-4-5P330E	REF		
R84	RES, DEP. CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7	REF		
R85	RES, DEP. CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20K	REF		
R86	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	2		
R87, R88	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	3		
R89	RES, MTL. FILM, 42.2K +/-1%, 1/8W	221655	91637	CMF554222F	1		
R90	RES, DEP. CAR, 150 +/-5%, 1/4W	343442	80031	CR251-4-5P150E	REF		
R92	RES, DEP. CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10K	REF		
U1⊗	IC, C-MOS, NAND GATES	375147	02735	CD4023AE	1	1	
U2	IC, TTL, HEX INVERTER, BUFFER/DRIVER	288605	01295	SN7416N	1	1	
U3	IC, LIN, OP AMP	329912	12040	LM318H	1	1	
U4	IC, OP AMP	225961	24355	AD3092	1	1	
U5	IC, LIN, OP AMP	288928	12040	LM308AH	1	1	
U6, U7	IC, LIN, OP AMP	284760	12040	LM308H	2	1	
U8	IC, LIN, OP AMP	381889	12040	LM201AH	1	1	
U9⊗	IC, C-MOS, HEX BUFFER/INVERTER	381848	20735	CD4049AE	1	1	
U10⊗	IC, C-MOS, HEX "D" FLIP FLOP	404509	12040	MM74C174N	1	1	
U11⊗	IC, C-MOS, QUAD 2-INPUT NAND GATE	355198	04713	MC14011CD	1	1	
XQ15	SPACER, COMPONENT	152207	07047	10123DAP	1		

1 ORDER P/N 425281 FOR COMPLETE MODULE CASE ASSY., WITHOUT PCB ASSY.

2 RESISTORS ARE TC COMPENSATED AND MUST BE RETURNED FOR RESELECTION IF ANY REQUIRE REPLACEMENT. (R39, R48, R79 & R80)

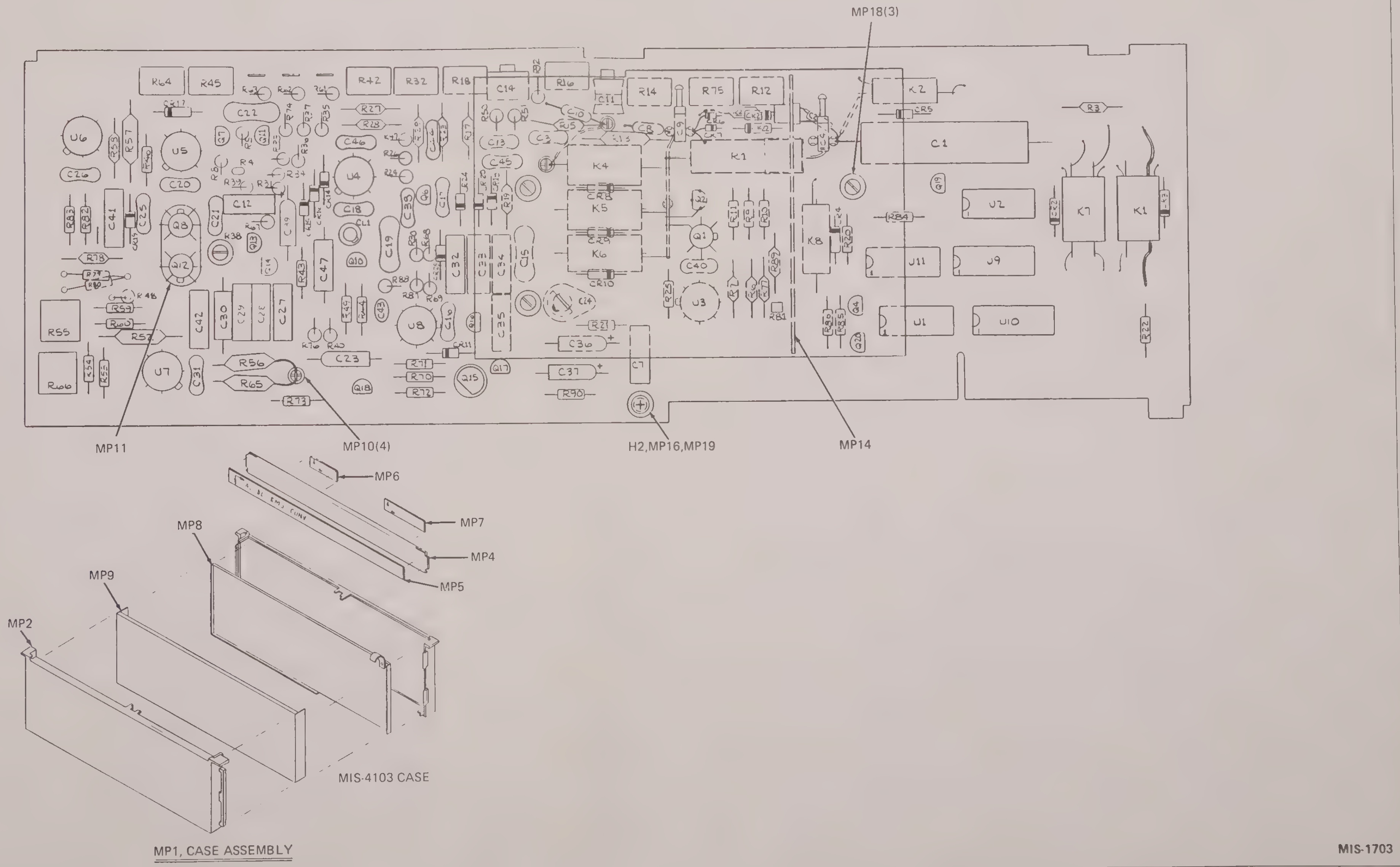
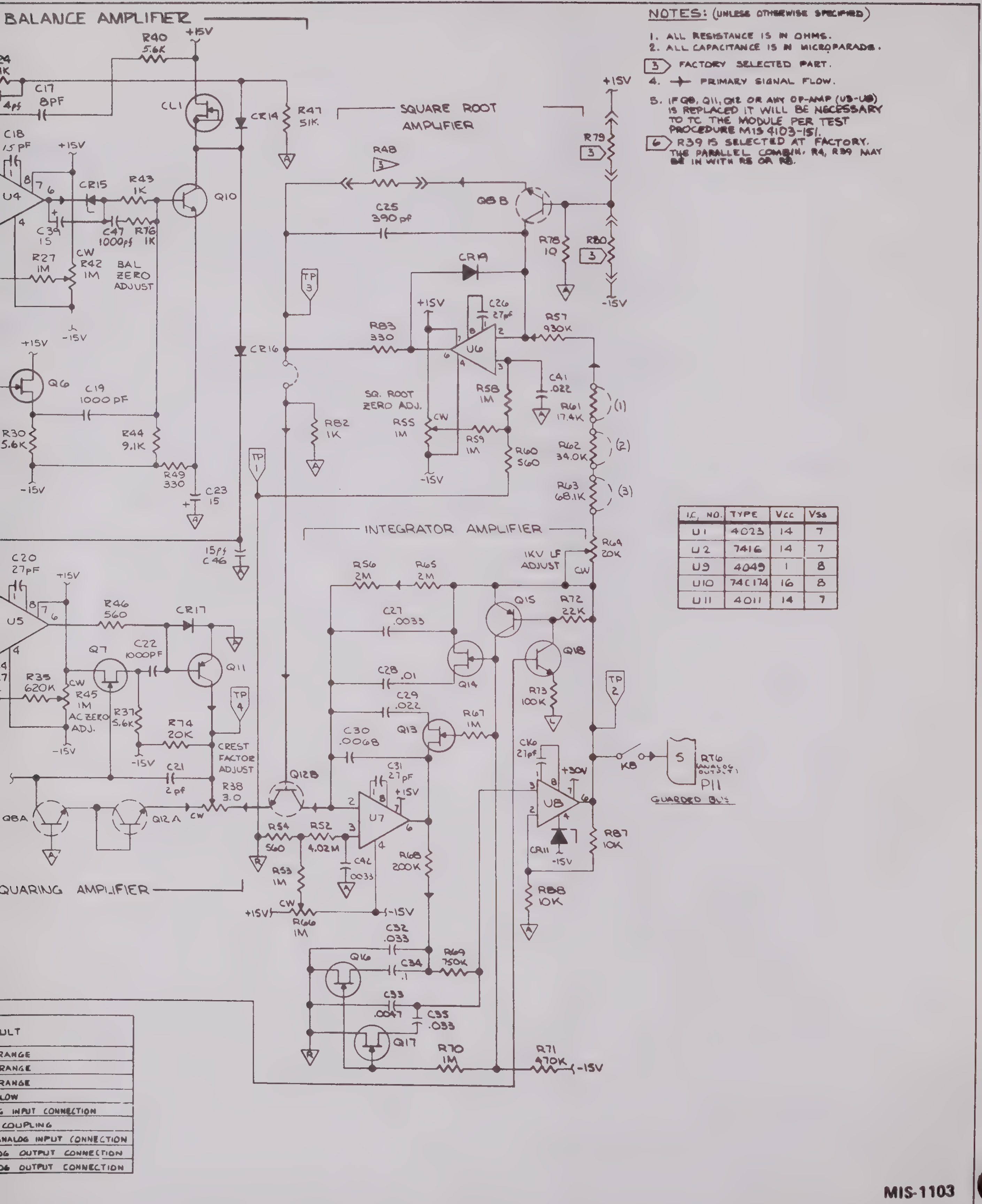

MP18(3)
MP11
MP10(4)
H2,MP16,MP19
MP14
MP6
MP7
MP4
MP5
MP8
MP9
MP2
MIS-4103 CASE
MP1, CASE ASSEMBLY
MIS-1703

Figure 609A-3. RMS Converter PCB Assembly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R40 5.6K
+15V
C17 8PF
CL1
CR14
R47 51K
SQUARE ROOT AMPLIFIER
C18 15 pF
+15V
U4
CR15
R43 1K
Q10
R48
3
Q8B
R79
3
+15V
C25 390 pF
C39 15
C47 1000pf
R76 1K
R27 1M
CW
R42 1M
BAL ZERO ADJUST
-15V
R78 1Ω
R80
3
CR19
TP 3
+15V
C26 27pf
R57 930K
-15V
+15V
Q6
C19 1000 PF
R83 330
CR16
U6
C41 .022
SQ. ROOT ZERO ADJ.
R58 1M
R61 17.4K
(1)
R82 1K
R55 1M
CW
R59 1M
R62 34.0K
(2)
R30 5.6K
R44 9.1K
R60 560
-15V
R49 330
TP 1
-15V
C23 15
R63 68.1K
(3)
INTEGRATOR AMPLIFIER
C20 27pF
15pf C46
R64 20K
1KV LF ADJUST
CW
+15V
R56 2M
R65 2M
U5
R46 560
CR17
C27 .0033
Q15
R72 22K
Q7
C22 1000PF
Q11
Q18
R35 620K
CW
R45 1M
AC ZERO ADJ.
R37 5.6K
C28 .01
Q14
TP 4
R73 100K
TP 2
-15V
R74 20K
C29 .022
R67 1M
Q13
C30 .0068
CK6 21pf
-15V
CREST FACTOR ADJUST
C21 2 pf
Q12B
C31 27 pF
+15V
+30V
K8
5
RT6 (ANALOG OUTPUT)
P11
GUARDED BUS
R38 3.0
U7
U8
Q8A
Q12A
CW
R54 560
R52 4.02M
C42 .0033
R68 200K
CR11
-15V
R87 10K
QUARING AMPLIFIER
R53 1M
CW
+15V
-15V
R66 1M
R88 10K
C32 .033
Q16
C34 .1
R69 750K
C33 .0047
C35 .033
Q17
R70 1M
R71 470K
-15V
ULT
RANGE
RANGE
RANGE
LOW
INPUT CONNECTION
COUPLING
NALOG INPUT CONNECTION
OG OUTPUT CONNECTION
OG OUTPUT CONNECTION
MIS-1103

NOTES: (UNLESS OTHERWISE SPECIFIED)

1. ALL RESISTANCE IS IN OHMS.
2. ALL CAPACITANCE IS IN MICROFARADS.

3 FACTORY SELECTED PART.

4. ⟶ PRIMARY SIGNAL FLOW.

5. IF Q8, Q11, Q12 OR ANY OP-AMP (U3-U8) IS REPLACED IT WILL BE NECESSARY TO TC THE MODULE PER TEST PROCEDURE MIS 4103-151.

6 R39 IS SELECTED AT FACTORY. THE PARALLEL COMBIN. R4, R39 MAY BE IN WITH R5 OR R6.

I.C. NO.	TYPE	Vcc	Vss
U1	4023	14	7
U2	7416	14	7
U9	4049	1	8
U10	74C174	16	8
U11	4011	14	7

Figure 609A-3. RMS Converter PCB Assembly (cont)

Section 7

General Information

7-1. This section of the manual contains generalized user information as well as supplemental information to the List of Replaceable Parts contained in Section 5.

List of Abbreviations and Symbols

A or amp	ampere
ac	alternating current
af	audio frequency
a/d	analog-to-digital
assy	assembly
AWG	american wire gauge
B	bel
bcd	binary coded decimal
°C	Celsius
cap	capacitor
ccw	counterclockwise
cer	ceramic
cermet	ceramic to metal(seal)
ckt	circuit
cm	centimeter
cmrr	common mode rejection ratio
comp	composition
cont	continue
crt	cathode-ray tube
cw	clockwise
d/a	digital-to-analog
dac	digital-to-analog converter
dB	decibel
dc	direct current
dmm	digital multimeter
dvm	digital voltmeter
elect	electrolytic
ext	external
F	farad
°F	Fahrenheit
FET	Field-effect transistor
ff	flip-flop
freq	frequency
FSN	federal stock number
g	gram
G	giga (10^9)
gd	guard
Ge	germanium
GHz	gigahertz
gmv	guaranteed minimum value
gnd	ground
H	henry
hd	heavy duty
hf	high frequency
Hz	hertz
IC	integrated circuit
if	intermediate frequency
in	inch(es)
intl	internal
I/O	input/output
k	kilo (10^3)
kHz	kilohertz
kΩ	kilohm(s)
kV	kilovolt(s)
lf	low frequency
LED	light-emitting diode
LSB	least significant bit
LSD	least significant digit
M	mega (10^6)
m	milli (10^{-3})
mA	milliampere(s)
max	maximum
mf	metal film
MHz	megahertz
min	minimum
mm	millimeter
ms	millisecond
MSB	most significant bit
MSD	most significant digit
MTBF	mean time between failures
MTTR	mean time to repair
mV	millivolt(s)
mv	multivibrator
MΩ	megohm(s)
n	nano (10^{-9})
na	not applicable
NC	normally closed
(–) or neg	negative
NO	normally open
ns	nanosecond
opnl ampl	operational amplifier
p	pico (10^{-12})
para	paragraph
pcb	printed circuit board
pF	picofarad
pn	part number
(+) or pos	positive
pot	potentiometer
p-p	peak-to-peak
ppm	parts per million
PROM	programmablle read-only memory
psi	pound-force per square inch
RAM	random-access memory
rf	radio frequency
rms	root mean square
ROM	read-only memory
s or sec	second (time)
scope	oscilloscope
SH	shield
Si	silicon
serno	serial number
sr	shift register
Ta	tantalum
tb	terminal board
tc	temperature coefficient or temperature compensating
tcxo	temperature compensated crystal oscillator
tp	test point
u or μ	micro (10^{-6})
uhf	ultra high frequency
us or μs	microsecond(s) (10^{-6})
uut	unit under test
V	volt
v	voltage
var	variable
vco	voltage controlled oscillator
vhf	very high frequency
vlf	very low frequency
W	watt(s)
ww	wire wound
xfmr	transformer
xstr	transistor
xtal	crystal
xtlo	crystal oscillator
Ω	ohm(s)
μ	micro (10^{-6})

Federal Supply Codes for Manufacturers

00213
Nytronics Comp. Group Inc.
Subsidiary of Nytronics Inc.
Formerly Sage Electronics
Rochester, New York

00327
Welwyn International, Inc.
Westlake, Ohio

00656
Aerovox Corp.
New Bedford, Massachusetts

00686
Film Capacitors, Inc.
Passaic, New Jersey

00779
AMP Inc.
Harrisburg, Pennsylvania

01121
Allen-Bradley Co.
Milwaukee, Wisconsin

01281
TRW Electronic Comp.
Semiconductor Operations
Lawndale, California

01295
Texas Instruments, Inc.
Semiconductor Group
Dallas, Texas

01537
Motorola Communications &
Electronics Inc.
Franklin Park, Illinois

01686
RCL Electronics Inc.
Manchester, New Hampshire

01730
Replaced by 73586

01884
Use 56289
Sprague Electric Co.
Dearborn Electronic Div.
Lockwood, Florida

02114
Ferroxcube Corp.
Saugerties, New York

02131
General Instrument Corp.
Harris ASW Div.
Westwood, Maine

02395
Rason Mfg. Co.
Brooklyn, New York

02533
Snelgrove, C.R. Co., Ltd.
Don Mills, Ontario, Canada
M3B 1M2

02606
Fenwal Labs
Div. of Travenal Labs.
Morton Grove, Illinois

02660
Bunker Ramo Corp., Conn Div.
Formerly Amphenol-Borg
Electric Corp.
Broadview, Illinois

02799
Areo Capacitors, Inc.
Chatsworth, California

03508
General Electric Co.
Semiconductor Products
Syracuse, New York

03614
Replaced by 71400

03651
Replaced by 44655

03797
Eldema Div.
Genisco Technology Corp.
Compton, California

03877
Transistron Electronic Corp.
Wakefield, Massachusetts

03888
KDI Pyrofilm Corp.
Whippany, New Jersey

03911
Clairex Electronics Div.
Clairex Corp.
Mt. Vernon, New York

03980
Muirhead Inc.
Mountainside, New Jersey

04009
Arrow Hart Inc.
Hartford, Connecticut

04062
Replaced by 72136

04202
Replaced by 81312

04217
Essex International Inc.
Wire & Cable Div.
Anaheim, California

04221
Aemco, Div. of
Midtex Inc.
Mankato, Minnesota

04222
AVX Ceramics Div.
AVX Corp.
Myrtle Beach, Florida

04423
Telonic Industries
Laguna Beach, California

04645
Replaced by 75376

04713
Motorola Inc. Semiconductor
Products
Phoenix, Arizona

04946
Standard Wire & Cable
Los Angeles, California

05082
Replaced by 94988

05236
Jonathan Mfg. Co.
Fullerton, California

05245
Components Corp. now
Corcom, Inc.
Chicago, Illinois

05277
Westinghouse Electric Corp.
Semiconductor Div.
Youngwood, Pennsylvania

05278
Replaced by 43543

05279
Southwest Machine &
Plastic Co.
Glendora, California

05397
Union Carbide Corp.
Materials Systems Div.
New York, New York

05571
Use 56289
Sprague Electric Co.
Pacific Div.
Los Angeles, California

05574
Viking Industries
Chatsworth, California

05704
Replaced by 16258

05820
Wakefield Engineering Inc.
Wakefield, Massachusetts

06001
General Electric Co.
Electronic Capacitor &
Battery Products Dept.
Columbia, South Carolina

06136
Replaced by 63743

06383
Panduit Corp.
Tinley Park, Illinois

06473
Bunker Ramo Corp.
Amphenol SAMS Div.
Chatsworth, California

06555
Beede Electrical Instrument Co.
Penacook, New Hampshire

06739
Electron Corp.
Littleton, Colorado

06743
Clevite Corp.
Cleveland, Ohio

06751
Components, Inc. Semcor Div.
Phoenix, Arizona

06860
Gould Automotive Div.
City of Industry, California

06961
Vernitron Corp., Piezo
Electric Div.
Formerly Clevite Corp., Piezo
Electric Div.
Bedford, Ohio

06980
Eimac Div.
Varian Associates
San Carlos, California

07047
The Ross Milton Co.
South Hampton, Pennsylvania

07115
Replaced by 14674

07138
Westinghouse Electric Corp.,
Electronic Tube Div.
Horsehead, New York

07233
TRW Electronic Components
Cinch Graphic
City of Industry, California

07256
Silicon Transistor Corp.
Div. of BBF Group Inc.
Chelmsford, Massachusetts

07261
Aumet Corp.
Culver City, California

07263
Fairchild Semiconductor
Div. of Fairchild Camera
& Instrument Corp.
Mountain View, California

07344
Bircher Co., Inc.
Rochester, New York

07597
Burndy Corp.
Tape/Cable Div.
Rochester, New York

07792
Lerma Engineering Corp.
Northampton, Massachusetts

07910
Teledyne Semiconductor
Formerly Continental Device
Hawthorne, California

07933
Use 49956
Raytheon Co.
Semiconductor Div. HQ
Mountain View, California

08225
Industro Transistor Corp.
Long Island City, New York

Federal Supply Codes for Manufacturers (cont)

08261
Spectra Strip Corp.
Garden Grove, California

08530
Reliance Mica Corp.
Brooklyn, New York

08806
General Electric Co.
Miniature Lamp Products Dept
Cleveland, Ohio

08863
Nylomatic Corp.
Norrisville, Pennsylvania

08988
Use 53085
Skottie Electronics Inc.
Archbald, Pennsylvania

09214
G.E. Co. Semi-Conductor
Products Dept.
Power Semi-Conductor
Products OPN Sec.
Auburn, New York

09353
C and K Components
Watertown, Massachusetts

09423
Scientific Components, Inc.
Santa Barbara, California

09922
Burndy Corp.
Norwalk, Connecticut

09969
Dale Electronics Inc.
Yankton, S. Dakota

10059
Barker Engineering Corp.
Formerly Amerace, Amerace
ESNA Corp.
Kenilworth, New Jersey

11236
CTS of Berne
Berne, Indiana

11237
CTS Keene Inc.
Paso Robles, California

11358
CBS Electronic Div.
Columbia Broadcasting System
Newburyport, Minnesota

11403
Best Products Co.
Chicago, Illinois

11503
Keystone Columbia Inc.
Warren, Michigan

11532
Teledyne Relays
Hawthorne, California

11711
General Instrument Corp.
Rectifier Division
Hicksville, New York

11726
Qualidyne Corp.
Santa Clara, California

12014
Chicago Rivet & Machine Co.
Bellwood, Illinois

12040
National Semiconductor Corp.
Danburry, Connecticut

12060
Diodes, Inc.
Chatsworth, California

12136
Philadelphia Handle Co.
Camden, New Jersey

12300
Potter-Brumfield Div.
AMF Canada LTD.
Guelph, Ontario, Canada

12323
Presin Co., Inc.
Shelton, Connecticut

12327
Freeway Corp. formerly
Freeway Washer & Stamping Co.
Cleveland, Ohio

12443
The Budd Co. Polychem Products
Plastic Products Div.
Bridgeport, Pennsylvania

12615
U.S. Terminals Inc.
Cincinnati, Ohio

12617
Hamlin Inc.
Lake Mills, Wisconsin

12697
Clarostat Mfg. Co.
Dover, New Hampshire

12749
James Electronics
Chicago, Illinois

12856
Micrometals
Sierra Madre, California

12954
Dickson Electronics Corp.
Scottsdale, Arizona

12969
Unitrode Corp.
Watertown, Massachusetts

13103
Thermalloy Co., Inc.
Dallas, Texas

13327
Solitron Devices Inc.
Tappan, New York

13511
Amphenol Cadre Div.
Bunker-Ramo Corp.
Los Gatos, California

13606
Use 56289
Sprague Electric Co.
Transistor Div.
Concord, New Hampshire

13839
Replaced by 23732

14099
Semtech Corp.
Newbury Park, California

14140
Edison Electronic Div.
Mc Gray-Edison Co.
Manchester, New Hampshire

14193
Cal-R-Inc. formerly
California Resistor, Corp.
Santa Monica, California

14298
American Components, Inc.
an Insilco Co.
Conshohocken, Pennsylvania

14655
Cornell-Dublier Electronics
Division of Federal Pacific
Electric Co. Govt. Control Dept.
Newark, New Jersey

14752
Electro Cube Inc.
San Gabriel, California

14869
Replaced by 96853

14936
General Instrument Corp.
Semi Conductor Products Group
Hicksville, New York

15636
Elec-Trol Inc.
Saugus, California

15801
Fenwal Electronics Inc.
Div. of Kidde Walter and Co., Inc.
Framingham, Massachusetts

15818
Teledyne Semiconductors,
formerly Amelco Semiconductor
Mountain View, California

15849
Litton Systems Inc. Useco Div.
formerly Useco Inc.
Van Nuys, California

15898
International Business
Machines Corp.
Essex Junction, Vermont

15909
Replaced by 14140

16258
Space-Lok Inc.
Burbank, California

16299
Corning Glass
Electronic Components Div.
Raleigh, North Carolina

16332
Replaced by 28478

16473
Cambridge Scientific Ind.
Div. of Chemed Corporation
Cambridge, Maryland

16742
Paramount Plastics
Fabricators, Inc.
Downey, California

16758
Delco Electronics
Div. of General Motors Corp.
Kokomo, Indiana

17001
Replaced by 71468

17069
Circuit Structures Lab.
Burbank, California

17338
High Pressure Eng. Co., Inc.
Oklahoma City, Oklahoma

17545
Atlantic Semiconductors, Inc.
Asbury Park, New Jersey

17856
Siliconix, Inc.
Santa Clara, California

17870
Replaced by 14140

18178
Vactec Inc.
Maryland Heights, Missouri

18324
Signetics Corp.
Sunnyvale, California

18612
Vishay Resistor Products Div.
Vishay Intertechnology Inc.
Malvern, Pennsylvania

18736
Voltronics Corp.
Hanover, New Jersey

18927
GTE Sylvania Inc.
Precision Material Group
Parts Division
Titusville, Pennsylvania

19451
Perine Machinery & Supply Co.
Seattle, Washington

19701
Electro-Midland Corp.
Mepco-Electra Inc.
Mineral Wells, Texas

20584
Enochs Mfg. Inc.
Indianapolis, Indiana

Federal Supply Codes for Manufacturers (cont)

20891
Self-Organizing Systems, Inc.
Dallas, Texas

21604
Bucheye Stamping Co.
Columbus, Ohio

21845
Solitron Devices Inc.
Transistor Division
Riveria Beach, Florida

22767
ITT Semiconductors
Palo Alto, California

23050
Product Comp. Corp.
Mount Vernon, New York

23732
Tracor Inc.
Rockville, Maryland

23880
Stanford Applied Engrng.
Santa Clara, California

23936
Pamotor Div., Wm. J. Purdy Co.
Burlingame, California

24248
Replaced by 94222

24355
Analog Devices Inc.
Norwood, Massachusetts

24655
General Radio
Concord, Massachusetts

24759
Lenox-Fugle Electronics Inc.
South Plainfield, New Jersey

25088
Siemen Corp.
Isilen, New Jersey

25403
Amperex Electronic Corp.
Semiconductor &
Micro-Circuits Div.
Slatersville, Rhode Island

27014
National Semiconductor Corp.
Santa Clara, California

27264
Molex Products
Downers Grove, Illinois

28213
Minnesota Mining & Mfg. Co.
Consumer Products Div.
St. Paul, Minnesota

28425
Serv-/-Link formerly
Bohannan Industries
Fort Worth, Texas

28478
Deltrol Controls Div.
Deltrol Corporation
Milwaukee, Wisconsin

28480
Hewlett Packard Co.
Corporate HQ
Palo Alto, California

28520
Heyman Mfg. Co.
Kenilworth, New Jersey

29083
Monsanto, Co., Inc.
Santa Clara, California

29604
Stackpole Components Co.
Raleigh, North Carolina

30148
AB Enterprise Inc.
Ahoskie, North Carolina

30323
Illinois Tool Works, Inc.
Chicago, Illinois

31091
Optimax Inc.
Colmar, Pennsylvania

32539
Mura Corp.
Great Neck, New York

32767
Griffith Plastic Corp.
Burlingame, California

32879
Advanced Mechanical
Components
Northridge, California

32897
Erie Technological Products, Inc.
Frequency Control Div.
Carlisle, Pennsylvania

32997
Bourns Inc.
Trimpot Products Division
Riverside, California

33173
General Electric Co.
Products Dept.
Owensboro, Kentucky

34333
Silicon General
Westminister, California

34335
Advanced Micro Devices
Sunnyvale, California

34802
Electromotive Inc.
Kenilworth, New Jersey

37942
P.R. Mallory & Co., Inc.
Indianapolis, Indiana

42498
National Radio
Melrose, Massachusetts

43543
Nytronics Inc.
Transformer Co. Div.
Geneva, New York

44655
Ohmite Mfg. Co.
Skokie, Illinois

49671
RCA Corp.
New York, New York

49956
Raytheon Company
Lexington, Massachusetts

50088
Mostek Corp.
Carrollton, Texas

50579
Litronix Inc.
Cupertino, California

51605
Scientific Components Inc.
Linden, New Jersey

53021
Sangamo Electric Co.
Springfield, Illinois

54294
Cutler-Hammer Inc. formerly
Shallcross, A Cutter-Hammer Co.
Selma, North Carolina

55026
Simpson Electric Co.
Div. of Am. Gage and Mach. Co.
Elgin, Illinois

56289
Sprague Electric Co.
North Adams, Massachusetts

58474
Superior Electric Co.
Bristol, Connecticut

60399
Torin Corp. formerly
Torrington Mfg. Co.
Torrington, Connecticut

63743
Ward Leonard Electric Co., Inc.
Mount Vernon, New York

64834
West Mfg. Co.
San Francisco, California

65092
Weston Instruments Inc.
Newark, New Jersey

66150
Winslow Tele-Tronics Inc.
Eaton Town, New Jersey
70485
Atlantic India Rubber Works
Chicago, Illinois

70563
Amperite Company
Union City, New Jersey

70903
Belden Corp.
Geneva, Illinois

71002
Birnback Radio Co., Inc.
Freeport, New York

71400
Bussmann Mfg.
Div. of McGraw-Edison Co.
Saint Louis, Missouri

71450
CTS Corp.
Elkhart, Indiana

71468
ITT Cannon Electric Inc.
Santa Ana, California

71482
Clare, C.P. & Co.
Chicago, Illinois

71590
Centrelab Electronics
Div. of Globe Union Inc.
Milwaukee, Wisconsin

71707
Coto Coil Co., Inc.
Providence, Rhode Island

71744
Chicago Miniature Lamp Works
Chicago, Illinois

71785
TRW Electronics Components
Cinch Connector Operations Div.
Elk Grove Village
Chicago, Illinois

72005
Wilber B. Driver Co.
Newark, New Jersey

72092
Replaced by 06980

72136
Electro Motive Mfg. Co.
Williamantic, Connecticut

72259
Nytronics Inc.
Pelham Manor, New Jersey

72619
Dialight Div.
Amperex Electronic Corp.
Brooklyn, New York

72653
G.C. Electronics
Div. of Hydrometals, Inc.
Brooklyn, New York

72665
Replaced by 90303
72794
Dzus Fastener Co., Inc.
West Islip, New York

72928
Gulton Ind. Inc.
Gudeman Div.
Chicago, Illinois

Federal Supply Codes for Manufacturers (cont)

72982
Erie Tech. Products Inc.
Erie, Pennsylvania

73138
Bechman Instrument Inc.
Helipot Division
Fullerton, California

73293
Hughes Aircraft Co.
Electron Dynamics Div.
Torrance, California

73445
Amperex Electronic Corp.
Hicksville, New York

73559
Carling Electric Inc.
West Hartford, Connecticut

73586
Circle F Industries
Trenton, New Jersey

73734
Federal Screw Products, Inc.
Chicago, Illinois

73743
Fischer Special Mfg. Co.
Cincinnati, Ohio

73899
JFD Electronics Co.
Components Corp.
Brooklyn, New York

73949
Guardian Electric Mfg. Co.
Chicago, Illinois

74199
Quan Nichols Co.
Chicago, Illinois

74217
Radio Switch Corp.
Marlboro, New Jersey

74276
Signalite Div.
General Instrument Corp.
Neptune, New Jersey

74306
Piezo Crystal Co.
Carlisle, Pennsylvania

74542
Hoyt Elect. Instr. Works
Penacook, New Hampshire

74970
Johnson E.F., Co.
Waseca, Minnesota

75042
TRW Electronics Components
IRC Fixed Resistors
Philadelphia, Pennsylvania

75376
Kurz-Kasch Inc.
Dayton, Ohio

75378
CTS Knights Inc.
Sandwich, Illinois

75382
Kulka Electric Corp.
Mount Vernon, New York

75915
Littlefuse Inc.
Des Plaines, Illinois

76854
Oak Industries Inc.
Switch Div.
Crystal Lake, Illinois

77342
AMF Inc.
Potter & Brumfield Div.
Princeton, Indiana

77638
General Instrument Corp.
Rectifier Division
Brooklyn, New York

77969
Rubbercraft Corp. of CA. LTD.
Torrance, California

78189
Shakeproof
Div. of Illinois Tool Works Inc.
Elgin, Illinois

78277
Sigma Instruments, Inc.
South Braintree, Massachusetts

78488
Stackpole Carbon Co.
Saint Marys, Pennsylvania

78553
Eaton Corp. Engineered
Fastener Div.
Tinnerman Plant
Cleveland, Ohio

79136
Waldes Kohinoor Inc.
Long Island City, New York

79497
Western Rubber Company
Goshen, Indiana

79963
Zierick Mfg. Corp.
Mt. Kisko, New York

80031
Electro-Midland Corp.
Mepco Div.
A North American Phillips Co.
Norristown, New Jersey

80145
LFE Corp., Process Control Div.
formerly API Instrument Co.
Chesterland, Ohio

80183
Use 56289
Sprague Products
North Adams, Massachusetts

80294
Bourns Inc., Instrument Div.
Riverside, California

80583
Hammarlund Mfg. Co., Inc.
Red Bank, New Jersey

80640
Arnold Stevens, Inc.
South Boston, Massachusetts

81073
Grayhill, Inc.
La Grange, Illinois

81312
Winchester Electronics
Div. of Litton Industries Inc.
Oakville, Connecticut

81483
Therm-O-Disc Inc.
Mansfield, Ohio

81483
International Rectifier Corp.
Los Angeles, California

81590
Korry Mfg. Co.
Seattle, Washington

81741
Chicago Lock Co.
Chicago, Illinois

82305
Palmer Electronics Corp.
South Gate, California

82389
Switchcraft Inc.
Chicago, Illinois

82415
North American Phillips
Controls Corp.
Frederick, Maryland

82872
Roanwell Corp.
New York, New York

82877
Rotron Inc.
Woodstock, New York

82879
ITT Royal Electric Div.
Pawtucket, Rhode Island

83003
Varo Inc.
Garland, Texas

83058
The Carr Co., United Can Div.
of TRW
Cambridge, Massachusetts

83298
Bendix Corp.
Electric Power Div.
Eatontown, New Jersey

83330
Herman H. Smith, Inc.
Brooklyn, New York

83478
Rubbercraft Corp.
of America, Inc.
West Haven, Connecticut

83594
Burroughs Corp.
Electronic Components Div.
Plainfield, New Jersey

83740
Union Carbide Corp.
Battery Products Div.
formerly Consumer Products Div.
New York, New York

84171
Arco Electronics
Great Neck, New York

84411
TRW Electronic Components
TRW Capacitors
Ogallala, Nebraska

84613
Fuse Indicator Corp.
Rockville, Maryland

84682
Essex International Inc.
Industrial Wire Div.
Peabody, Massachusetts

86577
Precision Metal Products
of Malden Inc.
Stoneham, Massachusetts

86684
Radio Corp. of America
Electronic Components Div.
Harrison, New Jersey

86928
Seastrom Mfg. Co., Inc.
Glendale, California

87034
Illuminated Products Inc.
Subsidiary of Oak Industries Inc.
Anahiem, California

88219
Gould Inc.
Industrial Div.
Trenton, New Jersey

88245
Litton Systems Inc.
Useco Div.
Van Nuys, California

88419
Cornell-Dubilier Electronic Div.
Federal Pacific Co.
Fuquay-Varian, North Carolina

88486
Plastic Wire & Cable
Jewitt City, Connecticut

88690
Replaced by 04217

89536
John Fluke Mfg. Co., Inc.
Seattle, Washington

89730
G.E. Co., Newark Lamp Works
Newark, New Jersey

Federal Supply Codes for Manufacturers (cont)

90201
Mallory Capacitor Co.
Div. of P.R. Mallory Co., Inc.
Indianapolis, Indiana

90211
Use 56365
Square D Co.
Chicago, Illinois

90215
Best Stamp & Mfg. Co.
Kansas City, Missouri

90303
Mallory Battery Co.
Div. of Mallory Co., Inc.
Tarrytown, New York

91094
Essex International Inc.
Suglex/IWP Div.
Newmarket, New Hampshire

91293
Johanson Mfg. Co.
Boonton, New Jersey

91407
Replaced by 58474

91502
Associated Machine
Santa Clara, California

91506
Augat Inc.
Attleboro, Massachusetts

91637
Dale Electronics Inc.
Columbus, Nebraska

91662
Elco Corp.
Willow Grove, Pennsylvania

91737
Use 71468
Gremar Mfg. Co., Inc.
ITT Cannon/Gremar
Santa Ana, California

91802
Industrial Devices, Inc.
Edgewater, New Jersey

91833
Keystone Electronics Corp.
New York, New York

91836
King's Electronics Co., Inc.
Tuckahoe, New York

91929
Honeywell Inc.
Micro Switch Div.
Freeport, Illinois

91934
Miller Electric Co., Inc.
Div. of Aunet
Woonsocket, Rhode Island

92194
Alpha Wire Corp.
Elizabeth, New Jersey

93332
Sylvania Electric Products
Semiconductor Products Div.
Woburn, Massachusetts

94145
Replaced by 49956

94154
Use 94988
Wagner Electric Corp.
Tung-Sol Div.
Newark, New Jersey

94222
Southco Inc. formerly
South Chester Corp.
Lester, Pennsylvania

95146
Alco Electronic Products Inc.
Lawrence, Massachusetts

95263
Leecraft Mfg. Co.
Long Island City, New York

95264
Replaced by 98278

95275
Vitramon Inc.
Bridgeport, Connecticut

95303
RCA Corp.
Receiving Tube Div.
Cincinnati, Ohio

95348
Gordo's Corp.
Bloomfield, New Jersey

95354
Methode Mfg. Corp.
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95712
Bendix Corp.
Electrical Components Div.
Microwave Devices Plant
Franklin, Indiana

95987
Weckesser Co. Inc.
Chicago, Illinois

96733
San Fernando Electric Mfg. Co.
San Fernando, California

96853
Gulton Industries Inc.
Measurement and Controls Div.
formerly Rustrak Instruments Co.
Manchester, New Hampshire

96881
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97540
Master Mobile Mounts, Div. of
Whitehall Electronics Corp.
Ft. Meyers, Florida

97913
Industrial Electronic
Hardware Corp.
New York, New York

97945
Penwalt Corp.
SS White Industrial Products Div.
Piscataway, New Jersey

97966
Replaced by 11358

98094
Replaced by 49956

98159
Rubber-Teck, Inc.
Gardena, California

98278
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98291
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Mamaroneck, New York

98388
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98743
Replaced by 12749

98925
Replaced by 14433

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99515
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99779
Use 29587
Bunker-Ramo Corp.
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Section 7A
Manual Change Information

INTRODUCTION

This section of the manual contains information necessary to backdate the manual to conform with earlier pcb configurations. To identify the configuration of the pcb's, refer to the revision letter (marked in ink) on the component side of each pcb assembly. Table 1 defines the revision levels documentated in this manual.

NEWER INSTRUMENTS

Changes and improvements made to the instrument are identified by incrementing the revision letter marked on the affected pcb assembly. These changes are documented on a supplemental change/errata sheet which, when applicable, is inserted at the front of the manual.

OLDER INSTRUMENTS

To backdate this manual to conform with earlier revision levels, perform the changes indicated in Table 1.

Table 7A-1. Manual Status and Backdating Information

Ref Or Option No.	Assembly Name	Fluke Part No.	* To adapt manual to earlier rev configurations perform changes in desending order (by no.), ending with change under desired rev letter																					
			—	A	B	C	D	E	F	G	H	J	K	L	M	N	P							
A1	Front Panel Display PCB Assy	639419	X																					
A2	Mother Board PCB Assy	639385	●	X																				
A3	Bus Interconnect PCB Assy	459636	X																					
A4	Power Supply PCB Assy	639526	●	X																				
A5	Power Supply Interconnect PCB Assy	645960	X																					
A6	Controller PCB Assy	638544	●	●	●	X																		
A7	Front/Rear Switch PCB Assy	646281	X																					
A8	DC Signal Conditioner PCB Assy	———																						
A9	Active Filter PCB Assy	383976	●	●	●	●	●	●	●	●	X													
A10A1	A/D Analog PCB Assy	383984	●	●	●	●	●	●	●	●	●	●	●	●	●	●	X							
A10A2	A/D Digital PCB Assy	383760	●	●	●	●	●	●	●	X														

* X = The PCB revision levels documented in this manual.
● = These revision letters were never used in the instrument.
—= No revision letter on the PCB.

Appendix 7B
Software Calibration

7B-1. INTRODUCTION

The 8505A and 8506A use a nonvolatile, read/write memory for microprocessor-controlled calibration of each range in each function. The Calibration Memory is a standard part of the Controller module with these multimeters. Extended intervals between hardware calibration are possible. The scale factor for each range can be calibrated using any reference input value from 60% of range to full scale. The following paragraphs first discuss the general procedure used in software calibration, then detail the procedure used for each function.

CAUTION

Interruption of input power could affect Calibration Memory entries when the multimeter is in Calibration mode. Do not cycle input power to the multimeter when Calibration mode is activated. If power is ON, locally verify that the AVG/(CAL) annunciator is not flashing or remotely verify that Calibration mode is off (G5 response = 0) before cycling power to OFF. If power is OFF, verify that the rear panel Calibration switch is off before cycling power to ON.

Software calibration entails a combination of zero offset and gain corrections. The Calibration mode must be activated when making calibration entries from either a local or remote location. This mode can only be entered by accessing the Calibration switch on the multimeter rear panel. The calibration sticker must be removed and the slide switch positioned to ON when the multimeter is in local (front panel) control. The front panel AVG/(CAL) annunciator flashes to denote activation of Calibration mode. Zero correction values can then be entered for each range in dc voltage (VDC) and resistance (OHMS) functions only. Gain correction factors can be stored for each range in each function by applying a reference input and entering a numeric string representing that reference value. The multimeter then computes the gain correction factor necessary to read the reference value. Depending on the function being calibrated, gain corrections are made once or twice for each range. A number representing the calibration date or identifying the multimeter can also be entered when the Calibration mode is activated.

The zero offset correction values are applied to the reading whenever the Zero mode is on (ZERO annunciator lighted). The gain correction factors are applied to the reading immediately upon entry and continue to be applied whether Calibration mode is on or off.

Locally, application of zero values can be interrupted by turning the Zero mode off. Remotely, both zero values and gain correction factors can be inhibited or enabled with the following commands:

1. M : inhibit gain correction factors
2. M 0 : enable gain correction factors
3. M 1 : inhibit zero values
4. M 2 : enable zero values

The multimeter may be interrogated from local or remote locations (Calibration mode on or off) for recall of zero values (VDC or OHMS) or the calibration date (multimeter identification) number. The last uncorrected reading can also be recalled from the front panel at any time. Remotely, uncorrected readings can be verified by sending a calibration factor inhibit command (M) and commanding a new reading.

Software calibration offers numerous benefits. Physical access to the multimeter is not necessary: no cover need be removed. Uncertainties due to internal temperature differentials and thermal equilibrium can thereby be eliminated. The procedure also proves convenient where the multimeter is stacked or mounted in a rack. The multimeter does not need to be removed from the system during software calibration: the procedure can be accomplished from local (front panel) or remote locations.

When the multimeter is in Calibration mode (AVG/(CAL) annunciator flashes) the following special conditions should be noted:

1. Locally, the multimeter display is altered to provide 7-1/2 digits on the 10V dc volts range and 6-1/2 digits on all other ranges and functions. Overrange indications (flashing H's) are not available. On the 8506A only, underrange indications (flashing L's) are not available.

CAUTION

Do not disable latching errors during multimeter calibration. The latching error disable feature is useful during troubleshooting (when normally disallowed module configurations may be necessary). Since latching errors may also identify an over voltage condition (as with local Error 4 or remote error 14), discretion must be used.

2. Averaging mode is locked out (Calibration and Averaging modes are mutually exclusive). However, the AVG button can be pushed locally to disable latching error conditions. Pushing AVG a second time enables latching errors once again.

3. All mathematic operations (Offset, Scaling, External Reference) and special operations (Limits, Peaks) are disabled.

7B-2. DESCRIPTION

The function being calibrated determines the calibration corrections that are available. Applicable correction points are summarized in Table 1. DC voltage (VDC) uses all three possible correction points (zero, positive, negative) and is used as an example in the following discussion. Refer to Figure 1 and Table 1. The dc voltage function requires that a zero correction and negative and positive gain corrections be made. Software algorithms ($Y=MX + C$) are used to perform these corrections. The constant C represents the zero correction value. This value can be stored on any range in the dc voltage (VDC) or resistance (OHMS) function. The constant M is computed by the multimeter. This computation is made by dividing the actual reference input (entered as a numeric) by the measured reference input (the uncorrected reading). Separate computations are made for negative and positive inputs.

Table 1. Calibration Points

FUNCTION	CALIBRATION POINTS			
	Zero Corrections	Positive Gain	Negative Gain	Specified Frequencies
8505A Software Calibration				
DC Volts (VDC or V)	X	X	X	
DC Amps (ADC or I)		X	X	
Ohms (OHMS or Z)	X	X		
AC Volts				
Averaging Option -01 (VAC or VA)				X
True-RMS Option 09A				
(VAC or VA)				X
(VAC+VDC or C)				X
AC Amps (AAC or IA)				X
8506A Software Calibration				
DC Volts (VDC or V)	X	X	X	
DC Amps (ADC or I)		X	X	
Ohms (OHMS or Z)	X	X		
AC Volts				
(HI ACCUR or VA2)				X
(HI ACCUR+VDC or C2)				X

For example, assume that the 1V dc range is being calibrated from the front panel. VDC zero (point A in Figure 1) is first performed with the multimeter input shorted to define the offset constant C. The positive gain correction constant M is then defined using any reference value from 600 mV (60% of range) to 2V (full scale). A value of 1.9V (point B in Figure 1) is selected in this case to minimize percentage of reading error and avoid saturation of the A/D Converter. Without correction, the multimeter reads 1.987250V. The correction constant M is therefore computed as:

$$M = \frac{1.9V}{1.987250V}$$

This linear correction factor is now applied to any input between 0 and +2V. Errors due to polarity reversals can be eliminated by storing a separate correction factor using a negative voltage. A procedure identical to that used with a positive reference input yields a linear gain correction that is applied to all inputs between −2V and 0.

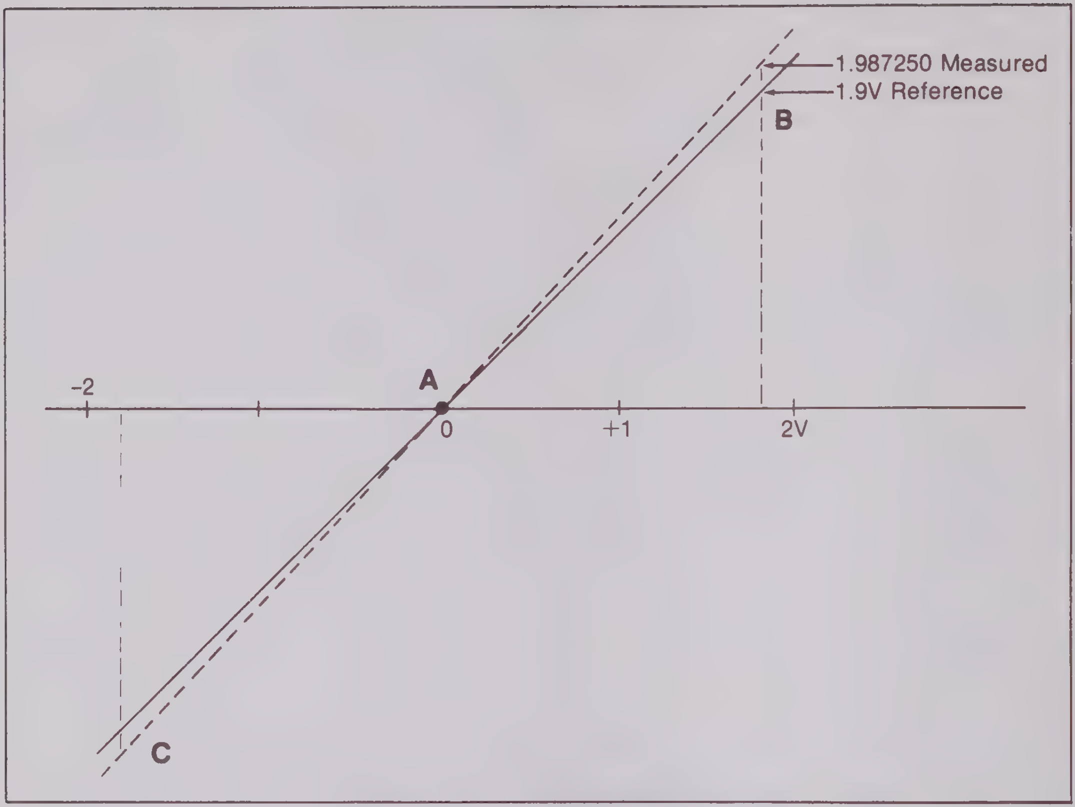

Figure 1. DC Voltage Calibration

Gain correction points for each function and range can be ascertained using Tables 1 and 2. For calibration of ac voltage, separate sets of correction points are used for the 8505A and the 8506A. A list of reference sources sufficiently accurate to calibrate the multimeters is presented in Table 3. Reference source connections are described in Section 4 (standard functions) and Section 6 (optional functions).

NOTE

The accuracy of the calibration correction factor reflects the accuracy of the reference source. To maintain accuracy, use only the sources listed in Table 3 or calibrated sources of equal or better accuracy.

7B-3. LOCAL (FRONT PANEL) CALIBRATION

Local calibration is carried out using several of the push buttons on the front panel. If necessary, refer to Section 2 of the appropriate Instruction Manual for a review of push button operation.

7B-4. Equipment Configurations

Front panel calibration can be made using zero or reference value connections either at the front panel terminals or through the rear input connector. Connections are described in Section 2 of the appropriate Instruction Manual. The following general considerations should be noted:

1. When using the front panel terminals, the three input selectors must be positioned as follows:
    a. Guard Selector: in or out, as required.

Table 2. Gain Correction Parameters

	RANGE	RECOMMENDED	MINIMUM	MAXIMUM
DC Volts	100 mV	190 mV	60 mV	200 mV
	1V	1.9V	0.6V	2V
	10V	19V	6V	20V
	100V	120V	60V	128V
	1000V	1000V	600V	1200V
Ohms	10 ohms	20 ohms	6 ohms	20 ohms
	100 ohms	200 ohms	60 ohms	200 ohms
	1 kohms	2 kohms	600 ohms	2 kohms
	10 kohms	20 kohms	6 kohms	25 kohms
	100 kohms	200 kohms	60 kohms	250 kohms
	1 Mohm	2 Mohms	600 kohms	4.1 Mohms
	10 Mohms	20 Mohms	6 Mohms	35 Mohms
	100 Mohms	100 Mohms	60 Mohms	265 Mohms
DC Amps	100 μA	190 μA	60 μA	250 μA
	1 mA	1.9 mA	600 μA	2 mA
	10 mA	10 mA	6 mA	16 mA
	100 mA	100 mA	60 mA	128 mA
	1A	1.0A	600 mA	1.28A
AC Amps (1) (8505A)	100 μA	200 μA	60 μA	312.5 μA
	1 mA	2.0 mA	600 μA	2.5 mA
	10 mA	19 mA	6 mA	20 mA
	100 mA	150 mA	60 mA	160 mA
	1A	1.0A	600 mA	1.28A
AC Volts (2) (8505A)	1V	2V	600 mV	2.5V
	10V	19V	6V	20V
	100V	100V	60V	160V
	1000V	900V	600V	1000V
AC Volts (3) (8506A)	100 mV	120 mV	60 mV	125 mV
	300 mV	390 mV	180 mV	400 mV
	1V	1.2V	600 mV	1.25V
	3V	3.9V	1.8V	4V
	10V	12V	6V	12.5V
	30V	35V	18V	40V
	100V	120V	60V	125V
	500V	500V	300V	600V

Notes:

1. Gain correction entered at 1 kHz. Actual value must be verified at source output.

2. Gain correction entered at 1 kHz, checked at 10 kHz, 50 kHz, 100 kHz (Averaging Converter Option -01) or at 100 kHz, 500 kHz, 1 MHz (True-RMS Converter Option -09A).

3. Gain correction entered at 1 kHz, checked at 10 kHz and 100 kHz.

Table 3. Reference Sources

NOMENCLATURE	MINIMUM USE SPECIFICATIONS	RECOMMENDED EQUIPMENT
DC Voltage		
DC Source	High Short-Term Stability (0-1100V)	Fluke Model 335A
Null Detector	10 μV Full-Scale Resolution	Fluke Model 335A
Kelvin-Varley Divider	Linearity ±1 ppm of Input	Fluke Model 750A
Standard Cell Enclosure	Guildline 91	Guildline 9152(R)
AC Voltage (8505A)		
AC Calibration System	0-1000V ac Accuracy: 1 kHz: .02% 10 kHz: .02% 50 kHz: .05% 100 kHz-1 MHz: .33%	Fluke Model 5200A with Fluke Model 5215A or 5205A
(refer to Section 4 for 8506A specifications, setup)		
Ohms		
Standard Resistors	20 ohm: 30 ppm 200 ohm - 20 Mohm: 50 ppm 200 Mohm: 100 ppm	ESI SR-1010 ESI SR-1050
DC Current		
DC Current Calibrator	Accuracy ±.02%	Fluke Model 382A
200 kohm Resistor	Accuracy ±.01%	
AC Current		
AC Current Calibrator	Verification Dependent	Fluke Model 5100

b. Ohms Selector: In (4T) for Ohms Zero and Ohms gain corrections (8505A and 8506A) and for VAC corrections (8506A only). The Guard Selector can be in or out for other calibration connections at the front panel terminals.

c. Rear Input Selector: out.

2. When the rear input connector is being used, the Guard Selector and the Ohms Selector have no affect. The Rear Input Selector must be pushed in. Rear inputs are dedicated to a four terminal configuration. Four terminal connections must be used for Ohms Zero and Ohms gain corrections (8505A and 8506A) and for VAC corrections (8506A).

7B-5. Zero Corrections

Zero corrections require activation of the Calibration mode (slide rear panel Calibration switch to on). Zero corrections can then be made separately for each range (without affecting values for other ranges) in dc volts and ohms functions. Each zero value stored is applied to subsequent readings in the selected range and function only. These values are stored permanently in Calibration Memory and can only be changed by storing new entries when Calibration mode is on.

Whenever Calibration mode is off, separate zero values can be stored in a temporary memory. This procedure is not used for software calibration and does not affect any software calibration zero values stored in the Calibration Memory. When this procedure is used, each stored zero value is applied in the existing range and in all higher ranges in the same function (dc volts or ohms). This process can be repeated for each range (from lowest to highest) if separate zero values must be temporarily stored for each range.

The zero value applied to the reading is defined as follows:

1. If Calibration mode is on, the permanent values stored in Calibration Memory during software calibration are applied.

2. When Calibration mode is turned off, temporary memory is loaded with permanent (Calibration Memory) values.

3. While the Calibration mode is off, the following conditions apply:

    a. Temporary zero values are applied.

    b. If a power-up or reset occurs during the Calibration mode off state, temporary memory zero values are re-initialized to the permanent (Calibration Memory) values.

    c. Zero values entered when Calibration mode is off change these initialized (or re-initialized) temporary memory values. Remember that any zero value entered with Calibration mode off is “read up” to all higher ranges in the same function.

7B-6. Gain Corrections

Corrections at reference input points require activation of the Calibration mode (slide rear panel Calibration switch to on). A reference input can be made at any point from 60% of range to full scale. Reference input parameters for each function are defined in Table 2. It is recommended that reference inputs near the full scale point be used to minimize reading errors. Reference sources are defined in Table 3. Reference source connections for standard functions (dc volts with the 8505A, dc volts and ac volts with the 8506A) are described in Section 4. Source connections for optional functions are described in Section 6. The following procedure is used for each range:

1. Manually select the range to be calibrated (push the up range or down range button).

2. Apply the reference value either to the front panel INPUT HI and LO terminals or through the rear panel input connector.

3. Allow the multimeter to take one reading.

4. Using the front panel push buttons, store the reference value defined by the source. For example, for a reference of 1.9V dc on the 1V dc range, push STORE 1 . 9 (CAL COR).

5. The multimeter computes the gain correction factor necessary to display the stored source value. This factor is then automatically applied to all subsequent readings in this function and range.

6. Verify proper entry of the reference value by allowing the multimeter to take a reading. This reading should be the actual reference value (±accuracy specifications for the multimeter function and range).

7. Repeat steps 1 through 6 for each range.

7B-7. Calibration Date (Multimeter Identification)

Up to six integers signifying the calibration date or identifying the multimeter can also be entered from the front panel. If the calibration date is being entered, the first two digits could represent the year, the third and fourth digits could define the month, and the fifth and sixth digits could represent the month. For example, January 1, 1983 is entered as STORE 8 3 0 1 0 1 (CAL DATE). Alternately, an instrument identification number of 242 is entered as STORE 2 4 2 (CAL DATE). Only integers may be entered: if a decimal point or exponent is used, an Error C condition is set. The multimeter can store only one set of six integers at a time.

7B-8. Recall Operations

The last uncorrected reading and the calibration date (or instrument identifying) number can be recalled for display at any time (Calibration mode on or off). If the Calibration mode is on (AVG/(CAL) annunciator flashes), the sequences used to recall the uncorrected reading and the number are, respectively:

RECALL (CAL COR)

RECALL (CAL DATE)

If the multimeter is not in the Calibration mode (AVG/(CAL) annunciator not flashing), the following sequences must be used:

RECALL LO (CAL COR)

RECALL LO (CAL DATE)

Zero values for the function selected (VDC or OHMS) can be recalled by pushing:

RECALL ZERO VDC/OHMS

This operation can be repeated for each range and does not affect either the stored zero value(s) or the zero mode status. If the multimeter is in VDC or OHMS, the zero value for the range and function selected is recalled. If the multimeter is not in VDC or OHMS, an Error 0 condition is set.

The value recalled may be either of the following:

1. If zero is recalled when the Calibration mode is off, the value displayed may differ from that actually stored in Calibration Memory. During a Calibration mode off condition, the multimeter stores separate, temporary zero values whenever the ZERO VDC/OHMS button is pushed. Such entries are recalled if both the following conditions are met:

   a. A power-up or reset has not occurred since the entry.

   b. Calibration mode is still off.

2. If Calibration mode is on, the recalled zero value is always that stored in Calibration Memory. Also, Calibration Memory zero values automatically replace the values held in the temporary storage referred to above when a power-up or reset condition occurs when Calibration mode is off.

7B-9. Error Conditions

The multimeter employs both momentary and latching errors. Once a momentary error automatically clears, further multimeter operation is not impaired. A latching error does not automatically clear and does impede further multimeter operation until the cause for the error has been corrected. Latching errors include Error, Error 2, Error 3, Error 4, Error 5, Error 9, and Error E. Latching errors are normally enabled, but are afforded special treatment when the Calibration mode is on. The following rules then apply:

CAUTION

Do not disable latching errors during multimeter calibration. The latching error disable feature is useful during troubleshooting (when normally disallowed module configurations may be necessary). Since latching errors may also identify an over voltage condition (as with local Error 4 or remote error 14), discretion must be used.

1. Latching errors are automatically enabled whenever Calibration mode is enabled or disabled with the rear panel Calibration Switch.

2. If Calibration mode is on, latching errors can be disabled by pushing the AVG button. Since Average mode and Calibration mode are mutually exclusive, this operation does not enable Average mode. The multimeter front panel display responds with (Err. oFF).

3. With Calibration mode still on, latching errors are re-enabled and normal Calibration mode operation is restored when the AVG button is pushed again. If a latching error condition exists at this time, the error message is displayed. If no latching error exists, the multimeter front panel display responds with (Err. on).

The front panel display identifies numerous potential error conditions. A full description of error conditions is presented in Section 2 of the appropriate Instruction Manual. The following list identifies error conditions specifically applicable to front panel calibration procedures.

1. Error 0: Store 0 error:
A zero STORE or RECALL has been attempted in an unallowed function. Zero corrections can only be made in VDC or OHMS.

2. Error 1: Store during overrange:
The STORE (CAL COR) sequence has been performed when the previously taken reading was overrange. This reading cannot be used in the multimeter's gain correction computation. The applied source value must be revised immediately to fall within the limits defined in Table 2. Damage to the multimeter could otherwise result. In any event, Error 1 signifies that the gain correction factor has not been stored. With a legal value applied to the multimeter, the numerics representing that value must be entered again with the STORE (CAL COR) sequence.

3. Error b: Not allowed in Calibration mode:
An unallowed push button sequence has been attempted in the Calibration mode. Use the correct sequence once the display has cleared.

4. Error C: Invalid push button sequence:
This error can occur under the following conditions:

   a. Numerics representing a value less than 60% of range or more than full scale have been entered during the STORE (CAL COR) sequence. Select a new value and repeat this sequence.

   b. The wrong sequence has been used to clear all Calibration Memory entries when the Calibration mode is activated.

   c. Error C also occurs when attempting to clear all Calibration Memory entries when not in Calibration mode.

5. Error d: Calibration Memory is faulty or not installed.

6. Error F: Calibration Memory check sum error:
This error condition may occur when power is applied, when storing into Calibration Memory, or during a recall operation. It may be caused by an inadvertent cycling of input power when the multimeter is in the Calibration mode. Reset the multimeter. If Error F remains, it may be necessary to first clear, and then reenter, all correction factors, zero values, and the calibration date (or instrument identification number). If Error F recurs during either the clearing procedure or a subsequent programming attempt, the Calibration Memory may be faulty.

NOTE

If an error condition identifies a faulty Calibration Memory chip, refer to Calibration Memory Replacement in Section 4. If a new Calibration Memory is installed, the comprehensive clearing procedure should first be performed, followed by re-programming of all desired entries.

7. Error H: Ohms input error:
This error can be caused by an open input during OHMS measurements, a bad protection fuse, or a polarity reversal in connections for four-terminal ohms measurements.

8. Error 4: Excessive voltage present at inputs (OHMS, ADC, AAC):
An improper input level has been used for ohms or resistance calibration. The appropriate function must be re-selected, and the input level must be revised.

9. Error E: Invalid module configuration:
A Calibration Memory module may be installed. The 8505A and 8506A do not use a separate module for calibration memory entries (calibration memory is a standard part of the Controller module). If a Calibration Memory module is installed, it must be removed. This error may also identify an illegal ac converter configuration. For the 8505A, only one ac converter (-01 Option or -09A Option) is allowed. For the 8506A, only the Thermal True-RMS Converter is allowed. Additional ac converters must be removed.

7B-10. Clear Operations

Calibration correction entries can also be removed or replaced from the front panel. The following procedures are available:

1. Applied zero correction values can be altered from the front panel as follows:

a. If temporary zero corrections have been entered while the Calibration mode is off, Calibration Memory zero values can be reinstated in temporary memory. With Calibration mode off, push the RESET button or cycle input power.

b. Application of all zero values can be disabled by pushing the ZERO VDC/OHMS button once (ZERO annunciator goes off).

c. New zero values can be entered by applying a short across the inputs and pushing the ZERO VDC/OHMS button again (ZERO annunciator comes on). When Calibration mode is on, this procedure creates a new Calibration Memory zero entry for the function (VDC or OHMS) and range selected only. If Calibration mode is off, this procedure creates a new temporary zero memory entry in the selected function (VDC or OHMS), the selected range, and all higher ranges. Zero values stored in temporary memory do not affect existing Calibration Memory entries.

2. Since only one or two gain correction factors are allowed per range (depending on the function), storing a new correction factor automatically replaces any previously stored correction factor. For those functions requiring two gain corrections per range (VDC and ADC), this operation must be performed twice (once for positive, once for negative) to ensure new correction factors for the full range of possible inputs.

NOTE

If hardware calibration is necessary, software calibration entries must first be cleared. The extent of hardware calibration determines the clearing operation required. If all functions are to be hardware calibrated, the procedure in step (4.) must be used. If select functions only are to be hardware calibrated, respective gain correction factors must be cleared with the procedure in step (3.), and zero factors must be disabled where appropriate.

3. Gain correction factors can be erased by using the STORE (CAL COR) sequence (without numerics) once for each range in each function. Using STORE (CAL COR) once clears both positive and negative gain corrections for the selected range in VDC or ADC.

4. Calibration memory factors for all ranges and functions, zero correction values for all VDC and OHMS ranges, and the calibration date (or instrument identifier) can also be erased using a single operation. This operation may be necessary if an Error F condition (check sum error) cannot be cleared with a multimeter reset or if it is necessary to clear software calibration entries for all functions prior to hardware calibration. With the multimeter in the Calibration mode, the following procedure is used:

a. To initialize the clear procedure, push STORE ZERO VDC/OHMS.

b. If the multimeter is not in the Calibration mode, a momentary Error C condition is set. After a brief pause, the multimeter reverts to the normal display to signify that no change has been initiated.

c. If the multimeter is in the Calibration mode, the display responds with: CLEAr?. At this point, the clear operation can be aborted and the existing correction factors retained by pushing any button other than ZERO VDC/OHMS. The multimeter would then respond with a momentary Error C display and revert to the normal Calibration mode display.

CAUTION

If RESET is pushed during the clearing interval, the clear operation may be interrupted prior to completion. A check sum (Error F) condition would then be set. Do not push the RESET button until the final clearing step (d) has been completed.

d. If the operation is to be completed (not aborted), all zero correction values, calibration correction factors, and the calibration date (instrument identification) number can be cleared by pushing the ZERO VDC/OHMS button a second time. Depending on the extent of Calibration Memory entries, the clear operation may require several seconds. Completion of the clear operation is verified by the removal of CLEAr?, a momentary blanking of the digit display, and extinguishment of the ZERO annunciator. If manual triggering is in effect, the display remains blank until the next manual trigger.

7B-11. REMOTE CALIBRATION

Remote calibration procedures are similar to those used fos front panel calibration. The parameters defined in Tables 1 and 2 are also used in remote calibration.

7B-12. Equipment Configurations

Remote calibration can be made using zero or reference value connections either at the front panel terminals or through the rear input connector. Connections are described in Section 2 of the appropriate Instruction Manual. The following general considerations should be noted:

1. When using the front panel terminals, the three input selectors must be positioned as follows:

    a. Guard Selector: in or out, as required.

    b. Ohms Selector: In (4T) for Ohms Zero and Ohms gain corrections (8505A and 8506A) and for VAC corrections (8506A only). The Guard Selector can be in or out for other calibration connections at the front panel terminals.

    c. Rear Input Selector: out.

2. When the rear input connector is being used, the Guard Selector and the Ohms Selector have no affect. The Rear Input Selector must be pushed in. Rear inputs are dedicated to a four terminal configuration. Four terminal connections must be used for Ohms Zero and Ohms Gain corrections (8505A and 8506A) and for VAC corrections (8506A only).

7B-13. Local/Remote Control

Remote calibration is carried out using any of the remote interface options available for the multimeter (IEEE-488, Bit Serial, or Parallel). Remote calibration requires that the multimeter be placed in local control prior to enabling the Calibration mode. Refer to the following local/remote control guidelines:

1. To select local control:

    a. From the front panel: push the LCL/RMT button and verify that the REMOTE annunciator is off.

b. From the remote location: send the # character (go to local, lockout remote) when using the Bit Serial Remote Interface (Option -06) or the Parallel Remote Interface (Option -07). With the IEEE-488 Remote Interface (Option -05), send a Go-to-Local (GTL) command.

2. To select remote control:

a. From the front panel: push the LCL/RMT button and verify that the REMOTE annunciator is on (Bit Serial and Parallel Interfaces only). With the IEEE-488 Interface, remote control cannot be selected from the front panel.

b. From the remote location: With the Bit Serial or Parallel Interface, remote control can be selected by sending any character that the multimeter recognizes. However, if local control was originally commanded with the # character, the front panel LCL/RMT button must be pushed. With the IEEE-488 Interface, remote is selected (with REN asserted) by sending an MLA. Some IEEE-interfaced controllers (such as the Fluke 1720A) automatically supply an MLA with any transmitted command string.

7B-14. Entry Format

Numeric entry commands are terminated by any subsequent non-numeric character. For calibration entries, an execution command must be included at the end of the string. Execution commands are not included in the instructions provided in this discussion but must be included in practice. The following terminating commands are available:

1. "," is used to execute the command string.
2. "?" is used to execute the command string and return a reading.
3. "@" is used to execute the command string, take a reading, and interrupt when ready.

7B-15. Zero Corrections

Storing zero values involves separate commands for the dc voltage and resistance functions. Calibration mode must be enabled when storing zero correction values during Software Calibration. With a high-quality, low-thermal shorting bar applied across SENSE HI and LO inputs, the zero value is stored as an offset (in the dc voltage function) by first allowing sufficient thermal voltage settling time, verifying that the multimeter has returned at least one reading, and then sending the K0 command. This operation stores the last reading as a dc voltage zero in the existing range and function. Ohms zero values are stored using the K1 command. The shorting bar must be applied to the HI and LO inputs in a four terminal configuration. Remote commands M1 (inhibit all zero values) and M2 (enable all zero values) can be sent at any time without affecting the stored values.

7B-16. Gain Corrections

The Calibration mode must be activated prior to entering gain correction factors. With the multimeter in local (front panel) control, the rear panel Calibration switch is positioned to ON (causing the AVG/(CAL) annunciator to begin flashing).

Gain corrections are initiated remotely with the KNG command. Reference values are the same as those used for front panel calibration. Source connections for standard functions (dc volts with the 8505A, dc volts and ac volts with the 8506A) are described in Section 4. Source connections for optional functions are described in Section 6. Remote verification of Calibration mode status can be made by sending the G5 command. A returned 0 signifies that the Calibration mode is off, and a returned 1 signifies that the Calibration mode is on.

Remote calibration for each range and function is accomplished by first taking a reading of the reference input and then programming the actual reference value. The programming step consists of the KNG command, followed by numerics representing the reference value. The first non-numeric following this entry terminates the numeric entry. The KNG command is only executed if followed by a terminating character (, ? or @). The multimeter now computes and stores the gain correction factor. If the KNG is not followed by a number, or is followed by zero, the gain correction for the range selected is disabled (none stored).

7B-17. Calibration Date (Multimeter Identification)

The identifying number can be programmed remotely with the KND command. As in front panel calibration, Calibration mode must first be activated. A maximum of six digits can be programmed following the KND command. One set of digits can be stored at a time. Digits could be entered for the day, month, and year of the calibration date. February 18, 1983 is programmed as K N D 2 1 8 8 3. Alternately, an instrument identification number of 242 is entered as K N D 2 4 2. Any non-numeric entry following these digits causes termination of the entry.

The digits programmed with the KND command can be recalled at any time (Calibration mode on or off) by sending the G4 command. The response is expanded to six digits with the inclusion of leading zeros (0 2 1 8 8 3, or 0 0 0 2 4 2 for the examples mentioned above).

7B-18. Recall Operations

Various commands are used to recall calibration entries. The following list identifies these commands:

1. G0: recall the dc voltage zero value. If the multimeter is in the dc voltage function, the zero value for the existing range is returned. If some other function is selected, the zero value for the 100 mV range is returned.

2. G2 : Recall multimeter configuration and send on next trigger. This recall command is useful in determining the multimeter type and identification number, verifying the installed modules prior to a performance test or calibration, and identifying the cause of an error 24 (illegal module configuration). A 22-character response identifies the multimeter and its hardware configuration as follows:

   a. Characters 1-5: the model number (e.g. 8506A)

   b. Characters 6-8: a special number (or blank)

   c. Character 9: a colon (:)

   d. Characters 10-22: 13 characters identifying the loaded modules.

      D : DC Signal Conditioner
      F : Active Filter
      C : A/D Converter
      1 : Averaging AC Converter (Option -01)
      2 : Ohms Converter (Option -02A)
      3 : Current Converter (Option -03)
      4 : Not used (always -)
      5 : IEEE-488 Interface (Option -05)
      6 : Bit Serial Interface (Option -06)
      7 : Parallel Interface (Option -07)
      8 : Isolator
      9 : True-RMS Converter (Option -09A)
      A : Thermal True-RMS Converter

Any module not installed is noted with a (-) in the response. For the 8505A, a response of DFC12----78-- would signify a standard dc volts configuration (DFC) with the Isolator (8) and options for averaging ac (1), ohms (2), and parallel interfacing (7). For the 8506A, a response of DFC--3-5--8-A would identify a standard dc volts (DFC) and thermal true-rms volts (A) configuration with the Isolator (8) and options for dc current (3) and IEEE-488 interfacing (5).

> Notes:
>
> (1) 8505A AC Volts (VA) uses either Averaging (Option -01) or True-RMS (Option -09A) converter. 8505A AC Amps (IA) uses Current Converter (Option -03) and either ac converter. If both ac converters are installed with ac volts or ac amps selected, the True-RMS converter (Option -09A) is used.
>
> (2) 8506A can use either the Ohms Converter (Option -02A) or the Current Converter (Option -03) - not both.
>
> (3) 8505A and 8506A: only one interface (Option -05, -06, or -07) can be installed at one time.

3. G4: recall the calibration date or instrument identification number on the next trigger. A total of six digits is returned - there is no leading zero suppression.

4. G5: recall Calibration mode status. A returned 0 identifies Calibration mode off, and a returned 1 identifies Calibration mode on.

5. G6: recall the ohms zero value. If the multimeter is in the ohms function, the zero value for the existing range is returned. If some other function is selected, the zero value for the 10 ohm range is returned.

6. M: inhibit calibration factors. This command can be used to take a reading with calibration correction disabled. Once the uncorrected reading has been noted, calibration correction factors can be enabled by sending the M0 command.

7B-19. Error Conditions

An error condition is identified by a user-defined response. This response is entered with the K3 command, followed by any combination of up to 15 characters. For example, an obviously illegal response of 1E20 could be specified to flag an error condition. If an error exists, this response is returned whenever a reading is attempted. The G1 (get status) command must then be sent to identify and note the specific error. This command can only be used once for each error response generated. The following error codes (defined in the first and second characters of the G 1 response) may be encountered during remote calibration:

1. 08 : Command string error

2. 10 : VDC/OHMS Zero error

3. 14 : Excessive voltage present (Ohms or Current function)
This is a latching error condition and necessitates, in sequence, revision of the input level and re-selection of the appropriate function prior to further calibration.

4. 16 : Numeric display overflow

5. 23 : The Calibration Memory is faulty or not installed.

6. 24 : Illegal module configuration
A Calibration Memory module may be installed. The 8505A and 8506A do not use a separate module for calibration memory entries (calibration memory is a standard part of the Controller module). Also, the wrong ac converter(s) may be installed. The 8505A uses either the -01 Option or the -09A Option (not both). The 8506A uses only the Thermal True-RMS Converter. Remove any disallowed module.

7. 25 : The Calibration Memory check sum is wrong.
This error condition may occur when applying power, when storing into Calibration Memory, or when recalling a Calibration Memory entry. It may be caused by an inadvertent cycling of power when the multimeter is in the Calibration mode. Reset the multimeter. If error 25 remains, it may be necessary to first clear, and then reenter, all correction factors, zero values, and the calibration date (or instrument identification number). If error 25 recurs during the clearing procedure or during any subsequent programming attempt, the Calibration Memory may be faulty.

NOTE

If an error condition identifies a faulty Calibration Memory chip, refer to Calibration Memory replacement in Section 4. If a new Calibration Memory is installed, the comprehensive clearing procedure should first be performed, followed by re-programming of all desired entries.

8. 27: Ohms connections are faulty.
Error 27 can occur when an ohms connection is open, a protection fuse is bad, or a polarity reversal has been made with the four-terminal connection.

7B-20. Clear Operations

The following procedures are available to remove or replace Calibration Memory entries from the remote location:

1. In the dc volts or ohms function, zero correction values can be replaced by entering new values. Existing values can be inhibited by sending the M1 command (or enabled with the M2 command).

2. Any Calibration Memory gain correction entry can be replaced by merely making a new entry. Where multiple gain correction factors are stored (as in dc volts), separate new factors must be stored (one for positive gain, one for negative gain).

3. Gain correction factors for the function selected can be erased by using the K N G 0 command string once for each range. Using K N G 0 once clears both positive and negative gain corrections for the selected range in dc volts (V) or dc amps (I).

NOTE

If hardware calibration is necessary, software calibration entries must first be cleared. The extent of hardware calibration determines the clearing operation required. If all functions are to be hardware calibrated, the procedure in step (5.) must be used. If select functions only are to be hardware calibrated, respective gain correction factors must be inhibited with the procedure in step (3.), and zero values must be disabled where appropriate.

4. All calibration factors can be inhibited (but not cleared) with the M command. The M0 command reapplies these factors.

CAUTION

If any interrupting command is sent immediately after K4 (and before G1), the comprehensive clearing operation may be interrupted prior to completion. A check sum (error 25) condition would then be set. Do not send any interrupting command (immediate characters, reset, etc.) between K4 and G1.

5. If it is necessary to clear all calibration factors (as in a check sum error 25 condition or prior to hardware calibration of all functions), the K4G1 command string can be used. Depending on the number of entries being cleared, several seconds may be necessary to complete this operation. Completion of this comprehensive clearing operation is verified by return of the status response.

7B-21. CALIBRATION PROCEDURES

7B-22. DC Voltage

7B-23. LOCAL (FRONT PANEL) PROCEDURE

Front panel dc voltage calibration can be accomplished using reference inputs and the front panel push buttons. Calibration mode must first be enabled by sliding the rear panel Calibration switch to ON (AVG/(CAL) annunciator flashes). Remember never to cycle input power to the multimeter when the Calibration mode is on. Then proceed as follows:

1. On the multimeter, select VDC function and 100 mV (manual) range.

2. Apply a good-quality, low-thermal shorting bar between INPUT SENSE HI and LO terminals. Allow sufficient thermal voltage settling time before proceeding to the next step.

3. Allow the multimeter to take at least one reading, then push the ZERO VDC/OHMS button.

4. Manually select the next higher VDC range, then push ZERO VDC/OHMS twice. In sequence, repeat this step for each higher VDC range. This procedure ensures that a discrete zero value is stored for each VDC range.

5. Remove the shorting bar.

6. Refer to Table 2 and select the reference value for the range being calibrated. Generally, any value between 60% of range and full scale may be selected. However, values near the full scale point ensure minimum percentage of reading error. Values too near the full scale point may cause saturation problems in the A/D Converter. The values given here (in parentheses) are recommended to both minimize percentage of reading error and avoid saturation problems.

7. Manually select the 10V range. With the reference value (19.000000V) applied to INPUT SENSE HI and LO terminals, push:
STORE (numerics of reference value) (CAL COR).

8. The gain correction is automatically applied to the next reading in this range. Verify proper reference value entry by observing that subsequent readings of the reference value equal that known value ± multimeter accuracy specifications. If

necessary, recall the uncorrected reading for comparison by using the RECALL (CAL COR) sequence.

9. Manually select the 100 mV range, apply an appropriate reference value (190.00000 mV), allow the multimeter to take one reading, push STORE (reference numerics) (CAL COR) once again, and verify the result. Repeat this procedure in sequence for each higher VDC range. The following reference values are recommended:

   a. 1V range: 1.9000000V

   b. 10V range: 19.000000V

   c. 100V range: 120.00000V

   d. 1000V range: 1000.0000V

10. The following steps store negative gain corrections for each range. Reverse the input connections to the multimeter.

11. Now return the reference source to the value used for the 10V range (19.000000V), and manually select the 10V range on the multimeter.

12. First allow the multimeter to take at least one reading, then push STORE (reference numerics) (CAL COR). Ignore polarity when entering numerics for the reference value.

13. The gain correction is automatically applied to the next reading in this range. Verify proper reference value entry by observing that subsequent readings of the reference value equal that known value ± multimeter accuracy specifications. If necessary, recall the uncorrected reading for comparison by using the RECALL (CAL COR) sequence.

14. Manually select the 100 mV range, apply an appropriate reference value (190.00000 mV), allow the multimeter to take at least one reading, push STORE (reference numerics) (CAL COR) once again, and verify the result. Using the preferred reference values mentioned above, repeat this procedure in sequence for each higher VDC range.

15. Set the reference output to zero, and remove connections between the reference source and the multimeter.

16. Front panel dc voltage calibration is complete once zero values and positive and negative gain corrections have been entered for each of the five ranges.

17. If no further calibration is required, disable the Calibration mode by sliding the rear panel switch to OFF.

7B-24. REMOTE PROCEDURE

Remote calibration employs the same sequence as that used for local calibration. The Calibration mode must be enabled when the multimeter is in local control (REMOTE annunciator off). The rear panel Calibration switch can then be positioned to ON (front panel AVG/(CAL) annunciator flashes) and remote control selected. Remember never to cycle input power to the multimeter when Calibration mode is on. The full calibration procedure is as follows:

1. Select the dc volts function (V) and 100 mV (manual) range (R0).

2. Apply a good-quality, low-thermal shorting bar between input SENSE HI and LO inputs. Allow sufficient thermal voltage settling time before proceeding to the next step.

3. Allow the multimeter to take at least one reading, then send K0 (store last reading as dc volts zero).

4. Send the next higher dc volts range command, allow the multimeter to return at least one reading, then send K0 again. In sequence, repeat this step for each higher dc volts range (R1, R2, R3, R4). This procedure ensures that a discrete zero value is stored for each dc volts range.

5. Remove the shorting bar.

6. Refer to Table 2 and select the reference value for the range being calibrated. Generally, any value between 60% of range and full scale may be selected. However, values near the full scale point ensure minimum percentage of reading error. Values too near the full scale point may cause saturation problems in the A/D Converter. The values given here (in parentheses) are recommended to both minimize percentage of reading error and avoid saturation problems.

7. Send the R2 command (10 volt range).

8. With the reference value (19.000000V) for the 10V range applied to SENSE HI and LO inputs, send the following command:

K N G (numerics of reference value)

9. The gain correction is automatically applied to the next reading in this range. Verify proper reference value entry by observing that subsequent readings of the reference value equal that known value ± multimeter accuracy specifications.

10. Revise the reference source output to the value used for the 100 mV range (190.00000 mV). Then send the R0 command.

11. Allow the multimeter to return at least one reading, then send KNG (reference numerics), and verify the result. Repeat this procedure in sequence for each higher dc volts range (R1, R2, R3, R4). The following reference values are recommended:

   a. 1V range (R1): 1.9000000V

   b. 10V range (R2): 19.000000V

   c. 100V range (R3): 120.00000V

   d. 1000V range (R4): 1000.0000V

12. Now send the R2 command again, and return the reference source to the value used for the 10V range (19.000000V).

13. The following steps store negative gain corrections for each range. Reverse the input connections to the multimeter.

14. First allow the multimeter to return at least one reading, then send KNG (reference numerics). Ignore polarity when entering numerics for the reference value.

15. The gain correction is automatically applied to the next reading in this range. Verify proper reference value entry by observing that subsequent readings of the reference value equal that known value ± multimeter accuracy specifications.

16. Apply a reference value appropriate for the 100 mV range (190.00000 mV), allow the multimeter to return at least one reading, send KNG (reference numerics), and verify the result. Using the preferred reference values mentioned above, repeat this procedure in sequence for each higher dc volts range (R1, R2, R3, R4).

17. Set the reference output to zero, and remove connections between the reference source and the multimeter.

18. Remote dc voltage calibration is complete once zero values and positive and negative gain corrections have been entered for each of the five ranges.

19. If no further calibration is required, disable the Calibration mode by sliding the rear panel switch to OFF.

7B-25. AC Volts

AC voltage software calibration involves storing one gain correction factor for each range. The type of multimeter (8505A or 8506A), the variety of ac converter installed, and the ac volts function selected (ac or ac + dc) are all factors that determine the exact procedure to use. Separate sets of ac volts gain corrections can be stored for the following configurations:

1. 8505A, Averaging Converter (Option -01) installed, VAC (VA) selected. AC + DC (C) cannot be selected for use with the Averaging Converter.

2. 8505A, True-RMS Converter (Option -09A) installed, VAC (VA) selected. If both the Averaging and True-RMS converters are installed, selecting VAC (VA) automatically connects the True-RMS Converter.

3. 8505A, True-RMS Converter (Option -09A) installed, VAC + VDC (C) selected.

4. 8506A, Thermal True-RMS Converter installed, VAC HI ACCUR (VA) selected.

5. 8506A, Thermal True-RMS Converter installed, VAC HI ACCUR + VDC (C) selected.

7B-26. 8505A AC VOLTS

The three possible ac volts configurations for the 8505A each require the same calibration procedure. First, a 1 kHz reference signal is applied at a level between 60% of range and full scale, and the reference level is entered numerically. Second, accuracy is checked at several higher frequencies. These accuracy checks are made at different sets of frequencies for the Averaging Converter and the True-RMS Converter.

7B-27. Local (Front Panel) Procedure

Refer to Table 2 for the allowed range of reference values and Table 3 for reference source requirements. Calibration mode must first be activated (with the multimeter in local control) by sliding the rear panel Calibration switch to ON (AVG/(CAL) annunciator flashes). Remember never to cycle input power to the multimeter when Calibration mode is on.

1. Select the ac volts function (VAC for either ac converter, VAC + VDC for True-RMS Converter only) and the lowest range (1V manual).

2. Select the appropriate reference value with the aid of Table 2. Recommended values are as follows:

   a. 1V range: 2V @ 1 kHz

   b. 10V range: 19V @ 1 kHz

   c. 100V range: 100V @ 1 kHz

   d. 1000V range: 900V @ 1 kHz

3. Apply this value to the INPUT SENSE HI and LO terminals and allow the multimeter to take at least one reading.

4. Now push the following buttons:

   STORE (reference value numerics)(CAL COR)

5. The multimeter computes the gain correction factor and automatically applies it to the next reading in this range. Verify proper reference value entry by observing that subsequent readings of the reference value equal that known value ± accuracy specifications. If necessary, recall the uncorrected reading for comparison by using the RECALL (CAL COR) sequence.

6. Verify accuracy at higher input frequencies. The required check frequencies (depending on the type of ac converter) are as follows:

   a. Averaging Converter (Option -01), VAC only: 10 kHz, 50 kHz, 100 kHz.

   b. True-RMS Converter (Option -09A), VAC or VAC + VDC: 100 kHz, 500 kHz, and 1 MHz.

7. Manually increment the range, apply the appropriate reference value (at 1 kHz), allow the multimeter to return at least one reading, and then push STORE (reference numerics) (CAL COR) once again.

8. Verify gain correction entry by either observing subsequent readings or using the RECALL (CAL COR) routine.

9. Verify accuracy at the higher frequencies specified above.

10. Repeat steps 7, 8, and 9 for each higher range (10V, 100V, 1000V).

11. Front panel ac volts calibration is complete once gain corrections have been entered for each of the five ranges. If required, a maximum of three sets of correction factors can be stored (one set each for Averaging Converter and VAC, True-RMS Converter and VAC, True-RMS Converter and VAC + VDC). Just repeat the entire procedure with the desired function and module. Remember that the True-RMS Converter is always selected if both ac converters are installed.

NOTE

If ac converters are improperly interchanged, software calibration is defeated. The calibration correction factors for each type of ac converter are stored in the Controller module. Therefore, it is possible to remove either type of ac converter, replace it with another ac converter of the same type, and retain software calibration factors. But remember, these factors are unique to the combination of the originally calibrated ac converter and this multimeter only.

12. If no further calibration is required, disable the Calibration mode by sliding the rear panel switch to OFF.

7B-28. Remote Procedure

Remote ac volts calibration can be carried out when the multimeter is in the Calibration mode. With the multimeter in local control, position the rear panel Calibration switch to ON. Refer to Table 2 for the allowed range of reference values and Table 3 for reference source requirements. Remember never to cycle input power to the multimeter when Calibration mode is on. Then select remote control and continue with the following procedure:

1. Send the appropriate ac volts command (VA for either ac converter, C for True-RMS Converter only) and the 1V range command (R1).

2. Select the appropriate reference value with the aid of Table 2. Recommended values are as follows:

   a. 1V range (R1): 2V @ 1 kHz

   b. 10V range (R2): 19V @ 1 kHz

   c. 100V range (R3): 100V @ 1 kHz

   d. 1000V range (R4): 900V @ 1 kHz

3. Apply this value to the SENSE HI and LO inputs and allow the multimeter to return at least one reading.

4. Now send the following commands:

   K N G (reference numerics)

5. The multimeter computes the gain correction factor and automatically applies it to the next reading in this range. Verify proper reference value entry by observing that subsequent returned readings of the reference value equal that known value ± accuracy specifications.

6. Verify accuracy at higher input frequencies. The required check frequencies (depending on the type of ac converter) are as follows:

   a. Averaging Converter (Option -01), VAC only: 10 kHz, 50 kHz, 100 kHz.

   b. True-RMS Converter (Option -09A), VAC or VAC + VDC: 100 kHz, 500 kHz, and 1 MHz.

7. Send the next higher range command, apply the appropriate reference value (at 1 kHz), allow the multimeter to return at least one reading, and then send KNG (reference numerics) once again.

8. Verify gain correction entry by observing subsequently returned readings.

9. Verify accuracy at the higher frequencies specified above.

10. Perform steps 7, 8, and 9 for each higher range (R2, R3, R4).

11. Remote ac volts calibration is complete once gain corrections have been entered for each of the five ranges. If required, a maximum of three sets of correction factors can be stored (one set each for Averaging Converter and VAC, True-RMS Converter and VAC, True-RMS Converter and VAC + VDC). Just repeat the entire procedure with the desired function and module. Remember that the True-RMS Converter is always selected if both ac converters are installed.

NOTE

If ac converters are improperly interchanged, software calibration is defeated. The calibration correction factors for each type of ac converter are stored in the Controller module. Therefore, it is possible to remove either type of ac converter, replace it with another ac converter of the same type, and retain software calibration factors. But remember, these factors are unique to the combination of the originally calibrated ac converter and this multimeter only.

12. If no further calibration is required, disable the Calibration mode by sliding the rear panel switch to OFF.

7B-29. 8506A AC VOLTS

The same procedure (1 kHz reference signal applied at a level between 60% or range and full scale, reference level entered numerically) is used for each range in High Accuracy mode for the 8506A. Gain corrections stored in High Accuracy mode are subsequently applied in all ac volts modes (High Accuracy, Enhanced, or Normal). Separate sets of gain corrections can be stored for VAC (VA2) or VAC and VDC (C2).

7B-30. Local (Front Panel) Procedure

Refer to Table 2 for the allowed range of reference values and Table 3 for reference source requirements. Calibration mode must first be activated (with the multimeter in local control) by sliding the rear panel Calibration switch to ON (AVG/(CAL) annunciator flashes). Remember never to cycle input power to the multimeter when Calibration mode is on.

1. Select the ac volts high accuracy function (VAC HI ACCUR) and 100 mV manual range.

2. Select the appropriate reference value with the aid of Table 2. Recommended values are as follows:

   a. 100 mV range: 120 mV @ 1 kHz

   b. 300 mV range: 390 mV @ 1 kHz

   c. 1V range: 1.2V @ 1 kHz

d. 3V range: 3.9V @ 1 kHz

e. 10V range: 12V @ 1 kHz

f. 30V range: 35V @ 1 kHz

g. 100V range: 120V @ 1 kHz

h. 500V range: 500V @ 1 kHz

3. Apply this value to the INPUT HI and LO terminals in a four-terminal configuration. Ensure that the Ohms Selector is pushed in (4T).

4. Allow the multimeter to take at least one reading, then push the following buttons:

STORE (reference value numerics) (CAL COR)

5. The multimeter computes the gain correction factor and automatically applies it to the next reading in this range. Verify proper reference value entry by observing that subsequent readings of the reference value equal that known value ± accuracy specifications. If necessary, recall the uncorrected reading for comparison by using the RECALL (CAL COR) sequence.

6. Verify accuracy at higher input frequencies. The required check frequencies are: 10 kHz and 100 kHz.

7. Manually increment the range, apply the appropriate reference value (at 1 kHz), allow the multimeter to return at least one reading, and then push STORE (reference numerics) (CAL COR) once again.

8. Verify gain correction entry by either observing subsequent readings or using the RECALL (CAL COR) routine.

9. Verify accuracy at the higher frequencies specified above.

10. Repeat steps 7, 8, and 9 for each higher range (1V, 3V, 10V, 30V, 100V, 500V).

11. Front panel ac volts calibration is complete once gain corrections have been entered for each of the eight ranges. If required, a separate set of correction factors can be stored for dc coupled ac volts (VAC HI ACCUR + VDC). Just repeat the entire procedure with the new function.

12. If no further calibration is required, disable the Calibration mode by sliding the rear panel switch to OFF.

7B-31. Remote Procedure

Remote ac volts calibration can be carried out when the multimeter is in the Calibration mode. With the multimeter in local control, position the rear panel Calibration switch to ON. Refer to Table 2 for the allowed range of reference values and Table 3 for reference source requirements. Remember never to cycle input power to the multimeter when Calibration mode is on. Then select remote control and continue with the following procedure:

1. Send the desired ac volts function command (VA2 for ac coupled, or C2 for dc coupled High Accuracy ac volts) and the R0 range command.

2. Select the appropriate reference value with the aid of Table 2. Recommended values are as follows:

   a. 100 mV range (R0): 120 mV @ 1 kHz

   b. 300 mV range (R1): 390 mV @ 1 kHz

   c. 1V range (R2): 1.2V @ 1 kHz

   d. 3V range (R3): 3.9V @ 1 kHz

   e. 10V range (R4): 12V @ 1 kHz

   f. 30V range (R5): 35V @ 1 kHz

   g. 100V range (R6): 120V @ 1 kHz

   h. 500V range (R7): 500V @ 1 kHz

3. Apply this value to the HI and LO SENSE inputs and allow the multimeter to return at least one reading.

4. Now send the following commands: K N G (reference numerics).

5. The multimeter computes the gain correction factor and automatically applies it to the next reading in this range. Verify proper reference value entry by observing that subsequent returned readings of the reference value equal that known value ± accuracy specifications.

6. Verify accuracy at higher input frequencies. The required check frequencies are: 10 kHz and 100 kHz.

7. Send the next higher range command, apply the appropriate reference value (at 1 kHz), allow the multimeter to return at least one reading, and then send KNG (reference numerics) once again.

8. Verify gain correction entry by observing subsequently returned readings.

9. Verify accuracy at the higher frequencies specified above.

10. Perform steps 7, 8, and 9 for each higher range (R2, R3, R4, R5, R6, R7).

11. Remote ac volts calibration is complete once gain corrections have been entered for each of the eight ranges. If required, a separate set of correction factors can be stored for dc coupled ac volts (C2). Just repeat the entire procedure with the new function selected.

12. If no further calibration is required, disable the Calibration mode by sliding the rear panel switch to OFF.

7B-32. Resistance

7B-33. LOCAL (FRONT PANEL) PROCEDURE

Front panel OHMS calibration is accomplished using zero corrections and positive gain corrections for each range. The Calibration mode must be enabled. With the multimeter in local control, the rear panel Calibration switch is positioned to ON (AVG/(CAL) annunciator flashes). Remember never to cycle input power to the multimeter when the Calibration mode is on. The complete calibration procedure is as follows:

1. Apply a good-quality, low-thermal shorting bar to the HI and LO inputs in a four wire configuration. If connections are made at the front panel terminals, the Ohms Selector must be in (4T) and the Guard Selector must be out (internal guard).

2. Allow sufficient thermal voltage settling time before proceeding to the next step.

3. Push the OHMS button and manually select the lowest range (10 ohms).

4. Allow the multimeter to take at least one reading. If an Error H condition is encountered, a multimeter protection fuse may be bad, or the four-terminal connections may be faulty. In either case, the problem must be corrected before proceeding with the calibration procedure.

5. Once a reading is properly returned, push the ZERO VDC/OHMS button.

6. Manually select the next higher OHMS range. Allow the multimeter to take at least one reading and then push ZERO VDC/OHMS twice. In sequence, repeat this step for each higher OHMS range. Eight ranges are zeroed in this fashion.

7. Remove the shorting bar.

8. Manually select the lowest OHMS range (10 ohms) once again.

9. Positive gain corrections are next stored for each OHMS range. Refer to Table 2 and select the reference resistance value for the range being calibrated. Recommended values are shown (in parentheses) in the following procedure. Also refer to Table 3 for reference resistance tolerance requirements.

10. With the reference resistance for the 10 ohm range (20 ohms) applied to the INPUT HI and LO terminals (four wire configuration), allow the multimeter to take at least one reading and then push:

    STORE (reference numerics) (CAL COR).

11. The gain correction is automatically applied to the next reading in this range. Verify proper reference value entry by observing that subsequent readings of the reference value equal that known value ± multimeter accuracy specifications. If necessary, recall the uncorrected reading for comparison by using the RECALL (CAL COR) sequence.

12. Manually increment the range, apply an appropriate reference resistance value, allow the multimeter to take at least one reading, and push STORE (reference numerics) (CAL COR) once again. Repeat this step in sequence for each higher OHMS range (total of eight). Recommended reference resistance values are as follows:

a. 100 ohm range: 200 ohms

b. 1 kohm range: 2 kohms

c. 10 kohm range: 20 kohms

d. 100 kohm range: 200 kohms

e. 1 Mohm range: 2 Mohms

f. 10 Mohm range: 20 Mohms

g. 100 Mohm range: 100 Mohms

13. Front panel resistance calibration is complete once zero corrections and positive gain corrections have been entered for each of the eight ranges.

14. If no further calibration is required, disable the Calibration mode by sliding the rear panel switch to OFF.

7B-34. REMOTE PROCEDURE

Remote resistance calibration follows the same pattern as that used for front panel calibration. Calibration mode must be enabled for all calibration procedures. With the multimeter in local control, position the rear panel Calibration switch to ON (AVG/(CAL) annunciator on front panel flashes). Remember never to cycle input power to the multimeter when the Calibration mode is on. Select remote control and use the following calibration procedure:

1. Apply a good-quality, low-thermal shorting bar to the HI and LO inputs in a four wire configuration. If connections are made at the front panel terminals, the Ohms Selector must be in (4T) and the Guard Selector must be out (internal guard). Allow sufficient thermal voltage settling time before proceeding to the next step.

2. Verify that ohms connections are correct and multimeter protection fuses are good before proceeding. Use the following sequence:

   a. Send the G2 command (recall status). Ignore the response.

   b. Send the ohms function command (Z) and the 10 ohm range command (R0).

   c. Trigger a reading. If the error response is returned, send G2 again. If error 27 is defined (first two digits of the response), the four terminal connections may be faulty or a protection fuse may be bad.

   d. In either case, correct the problem before proceeding with ohms software calibration.

3. Once a proper reading has been returned, send the K1 command (store last reading as ohms zero).

4. Send the next higher range command. Allow the multimeter to return at least one reading, and then send K1 again. In sequence, repeat this step for each higher OHMS range. Eight ranges are zeroed in this fashion.

5. Remove the shorting bar.

6. Send the R0 (10 ohms) command again.

7. Positive gain corrections are next stored for each OHMS range. Refer to Table 2 and select the reference resistance value for the range being calibrated. Recommended values are shown (in parentheses) in the following procedure. Also refer to Table 3 for reference resistance tolerance requirements.

8. With the reference resistance for the 10 ohm range (20 ohms) applied to the INPUT HI and LO terminals (four wire configuration), allow the multimeter to return at least one reading and then send:

K N G (reference numerics)

9. The gain correction is automatically applied to the next reading in this range. Verify proper reference value entry by observing that subsequently returned readings of the reference value equal that known value ± multimeter accuracy specifications.

10. Send the next higher range command, apply an appropriate reference resistance value, allow the multimeter to return at least one reading, and send KNG (reference numerics) once again. Repeat this step in sequence for each higher OHMS range (total of eight). Recommended reference resistance values are as follows:

    a. 100 ohm range (R1): 200 ohms

    b. 1 kohm range (R2): 2 kohms

    c. 10 kohm range (R3): 20 kohms

    d. 100 kohm range (R4): 200 kohms

    e. 1 Mohm range (R5): 2 Mohms

    f. 10 Mohm range (R6): 20 Mohms

    g. 100 Mohm range (R7): 100 Mohms

11. Remote resistance calibration is complete once zero corrections and positive gain corrections have been entered for each of the eight ranges.

12. If no further calibration is required, disable the Calibration mode by sliding the rear panel switch to OFF.

7B-35. DC Current

DC current calibration procedures are very similar to the positive and negative gain corrections used with dc voltage calibration. With the multimeter in local control, Calibration mode can be enabled by sliding the rear panel Calibration switch to ON (AVG/(CAL) annunciator flashes). Remember never to cycle input power to the multimeter when the Calibration mode is on.

7B-36. LOCAL (FRONT PANEL) PROCEDURE

Use the front panel push buttons as follows:

1. Push the ADC button and manually select the lowest (100 uA) dc current range.

2. Refer to Table 2 and select the reference value for the range being calibrated. Recommended reference values are mentioned in the following steps. Also refer to Table 3 for dc current reference source requirements.

3. With the reference value for the 100 uA range (190 uA) applied to the INPUT SOURCE HI and LO terminals, allow the multimeter to take at least one reading, then push:

STORE (numerics of reference value) (CAL COR)

4. The gain correction is automatically applied to the next reading in this range. Verify proper reference value entry by observing that subsequent readings of the reference value equal that known value ± multimeter accuracy specifications. If necessary, recall the uncorrected reading for comparison by using the RECALL (CAL COR) sequence.

5. Manually increment the range, apply the appropriate reference value, allow the multimeter to take at least one reading, and then push STORE (reference numerics) (CAL COR) once again. Repeat this step in sequence for each higher ADC range. Recommended reference values are as follows:

   a. 1 mA range: 1.9 mA

   b. 10 mA range: 10 mA

   c. 100 mA range: 100 mA

   d. 1A range: 1.0A

6. Return the reference output to the value used for the 100 uA range. Then manually select the 100 uA range on the multimeter.

7. Reverse the reference output polarity.

8. Repeat steps 3, 4, and 5. Ignore polarity when entering the reference value numerics.

9. Front panel dc current calibration is complete once positive and negative gain corrections have been entered for each of the five ranges.

10. If no further calibration is required, disable the Calibration mode by sliding the rear panel switch to OFF.

7B-37. REMOTE PROCEDURE

Remote dc current calibration employs the same sequence as used for local calibration. Proceed as follows:

1. Select the required function and range by sending: I (for dc current) and R0 (for 100 uA range).

2. Refer to Table 2 and select an appropriate reference value. Recommended reference values are shown in the following steps. Also refer to Table 3 for reference source requirements. Apply the selected reference value for R0 range (190 uA) to SOURCE HI and LO inputs.

3. Allow the multimeter to return at least one reading, then send: KNG (numerics of reference value).

4. Proper gain correction storage can be verified by comparing subsequently returned readings to the reference value(s) used ± multimeter accuracy specifications.

5. Increment the range by sending the next higher range command (R1, R2, R3, R4), apply an appropriate reference value, allow the multimeter to return at least one reading, and send K N G (reference numerics). Repeat this step for each higher range in the dc current function. Recommended reference values are as follows:

   a. 1 mA range (R1): 1.9 mA

   b. 10 mA range (R2): 10 mA

   c. 100 mA range (R3): 100 mA

   d. 1A range (R4): 1.0A

6. Return the reference output to the value used for the R0 (100 uA) range. Send the R0 command again to select the 100 uA range on the multimeter.

7. Reverse the reference output polarity.

8. Repeat steps 3, 4, and 5. Ignore polarity when sending reference value numerics.

9. Remote dc current calibration is complete once positive and negative gain corrections have been entered for each of the five ranges.

10. If no further calibration is required, disable the Calibration mode by sliding the rear panel switch to OFF.

7B-38. AC Current

The ac current function is available with the 8505A, but not with the 8506A. Before software calibration (using either the RMS Converter or the Averaging Converter) is carried out, the following conditions must be met:

1. The Current Shunts module (Option -03) must be installed.

2. Either the Averaging AC Converter (Option -01) or the True-RMS Converter (Option -09A) must be installed.

3. With the multimeter in local control, Calibration mode must be enabled by sliding the rear panel Calibration switch to ON (AVG/(CAL) annunciator flashes). Remember never to cycle input power to the multimeter when the Calibration mode is on.

4. AC current function (AAC push button, or remote command I A) must be selected.

7B-39. LOCAL (FRONT PANEL) PROCEDURE

Front panel AAC calibration is accomplished using gain correction factors at mid-band (1 kHz) for each range. The following procedure is used:

1. Select the ac current function (AAC) and manually select the 100 uA range.

2. Select the appropriate reference value with the aid of Table 2. The recommended value for the 100 uA range is 200 uA. Apply this value (verified level at 1 kHz) to the INPUT SOURCE HI and LO terminals.

NOTE

The actual reference level must be verified at the source output.

3. Allow the multimeter to take at least one reading. Now push the following buttons:

STORE (numerics for verified value) (CAL COR)

4. The gain correction is automatically applied to the next reading in this range. Verify proper reference value entry by observing that subsequent readings of the reference value equal that known value ± applicable accuracy specifications. If necessary, recall the uncorrected reading for comparison by using the RECALL (CAL COR) sequence.

5. On the multimeter, select the next higher range.

6. Select a reference value for the next higher multimeter range. Verify this reference value at the source output. Recommended reference values are as follows:

   a. 1 mA range: 2.0 mA @ 1 kHz

   b. 10 mA range: 19 mA @ 1 kHz

   c. 100 mA range: 150 mA @ 1 kHz

   d. 1A range: 1.0A @ 1 kHz

7. With the verified reference value (at 1 kHz) applied to the multimeter, allow at least one reading to be returned.

8. Now push STORE (numerics for verified reference value) (CAL COR) once again.

9. Repeat steps 5, 6, 7, and 8 for each higher range.

10. Front panel ac current calibration is complete once gain corrections have been entered for each of the five ranges.

11. If no further calibration is required, disable the Calibration mode by sliding the rear panel switch to OFF.

7B-40. REMOTE PROCEDURE

Remote ac current calibration is accomplished using gain correction factors at mid-band (1 kHz) for each range. The following procedure is used:

1. Select the required function and range by sending I A (for ac current) and R 0 (for 100 uA range).

2. Refer to Table 2 and select an appropriate reference value. The recommended value for the 100 uA range (R0) is 200 uA at 1 kHz. Apply this value (verified level at 1 kHz) to the Source Hi and Lo inputs.

NOTE

The actual reference level must be verified at the source output.

3. Allow the multimeter to return at least one reading.

4. Now send: K N G (numerics for verified reference level).

5. Proper gain correction storage can be verified by comparing subsequently returned readings of the reference value to that known value ± applicable accuracy specifications.

6. Increment the multimeter range by sending the next higher range command.

7. Select a reference value for the next higher multimeter range. Verify this value at the source output. Recommended reference values are as follows:

   a. 1 mA range (R1): 2.0 mA @ 1 kHz

   b. 10 mA range (R2): 19 mA @ 1 kHz

   c. 100 mA range (R3): 150 mA @ 1 kHz

   d. 1A range (R4): 1.0A @ 1 kHz

8. With the verified reference value applied, allow the multimeter to return at least one reading.

9. Now send K N G (numerics for verified reference level).

10. Repeat steps 6, 7, 8, and 9 for each of the remaining ac current ranges.

11. Remote ac current calibration is complete once gain corrections have been entered for each of the five ranges.

12. If no further calibration is required, disable the Calibration mode by sliding the rear panel switch to OFF.

7B-41. SPECIFICATIONS

Use of software calibration allows for extended intervals between hardware calibration. Software calibration can be performed at any time, as determined by the user's accuracy requirements. Specifications attainable with software calibration are defined in Section 1 (standard functions) and Section 6 (optional functions). If the multimeter has been repaired, hardware calibration may be necessary. Once hardware calibration has been carried out, 24-hour specifications are in effect and immediate software calibration is not necessary.

Section 8
Schematic Diagrams

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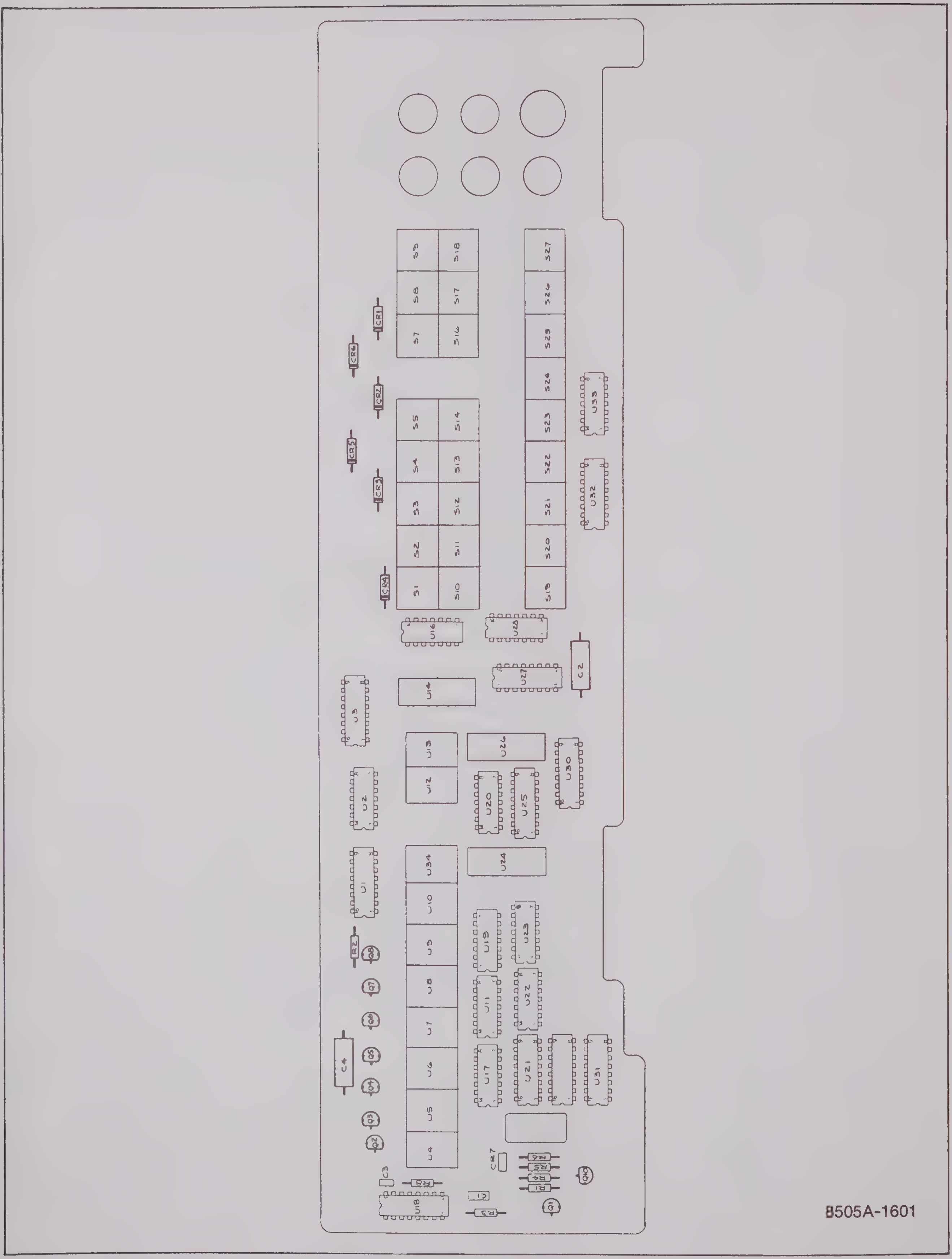
LIST OF MNEMONICS

A0-A15	Address bus on controller
ACK	Acknowledge signal from module
ACKINT	Interrupt generated when module does not respond
CPUINT	Interrupt signal for µP
CPUREADY	Ready signal for µP
CPURESET	Reset signal
D0-D7	Data bus on controller
DBIN	Data bus input signal (from µP)
DLDACK	Delayed version of ACK
EXTCOM	Module communication signal
EXTINT	Interrupt from module
FLINE	Shaped line frequency signal
8xFLINE	8 times line frequency
FRONT/REAR	Front or rear input signal
IC0-IC7	Module address/control bus
ICENABLE	Enable module address signal
ID0-ID7	Module data bus
INA	Interrupt acknowledge signal in response to EXTINT
INP	I/O status signal
INTA	Interrupt acknowledge status signal
INTCLR	Clear interrupt signal
LINEREF	Line reference signal, bus input on RT5
MARKINT	Interrupt to synchronize to line frequency
Ø1	One phase of µP clock
Ø2	Other phase of µP clock
OUT	I/O status signal
READY	Signal to generate CPUREADY
RESET	Reset signal
RUN	Exit wait state signal
SCANADV	Scan advance signal, A/D conversion complete
STOP	Enter wait state signal
STSTB	Clock signal to latch µP status
SYNC	Signal from µP, used to generate STSTB
SYNCDEXTINT	Synchronized interrupt from module
Vbb	-5V supply
Vcc	+5V supply
Vdd	+12V supply
Vgg	-12V supply
Vss	Logic common
WAIT	µP in wait state signal
WR	Write data signal from µP


S9
S18
S27
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S16
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S21
S20
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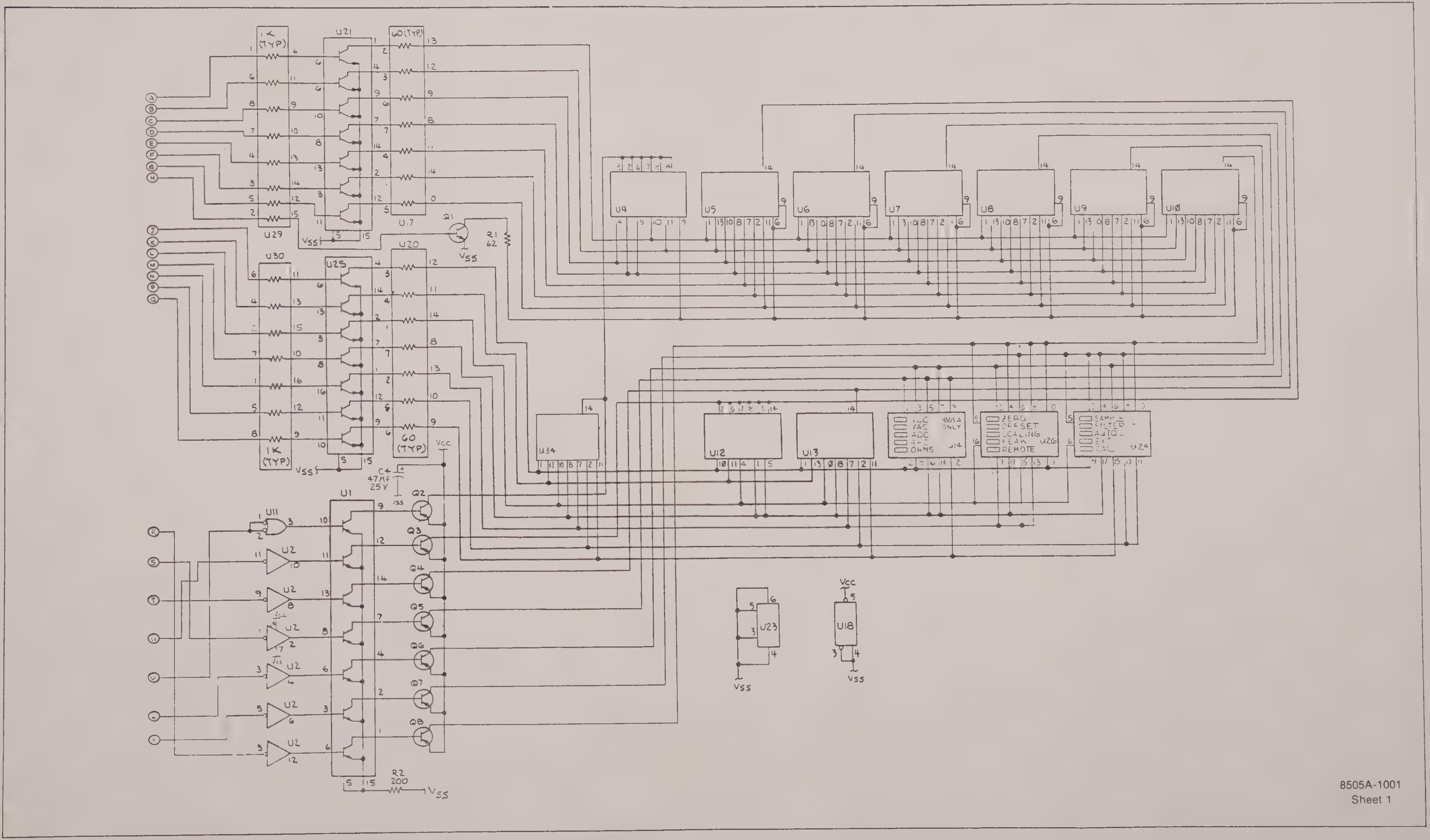
S5
S14
S4
S13
S3
S12
S2
S11
S1
S10
CR1
CR6
CR2
CR5
CR3
CR4
U33
U32
U16
U28
C2
U27
U14
U3
U13
U26
U30
U12
U2
U20
U25
U34
U24
U1
U10
U19
U23
U9
R2
Q8
Q7
U8
U11
U22
Q6
U7
C4
Q5
U6
U17
U21
U31
Q4
U5
Q3
Q2
U4
CR7
R6
R5
R4
R1
Q10
C3
R7
J
U18
R3
Q1
8505A-1601

Figure 8-1. A1 Front Panel Display PCB Assembly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U21
60 (TYP)
U7
Q1
R1 62
VSS
U30
U25
U20
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60 (TYP)
U4
U5
U6
U7
U8
U9
U10
U34
U12
U13
VDC
VAC
ADC
OHMS
8505A ONLY
U14
ZERO
OFFSET
SCALING
PEAK
REMOTE
U26
SAMPLE
FILTER
AUTO
EXT
CAL
U24
VCC
C4 47µF 25V
U1
U11
U2
Q2
Q3
Q4
Q5
Q6
Q7
Q8
R2 200
U23
U18
8505A-1001
Sheet 1

Figure 8-1. A1 Front Panel Display PCB Assembly (cont)

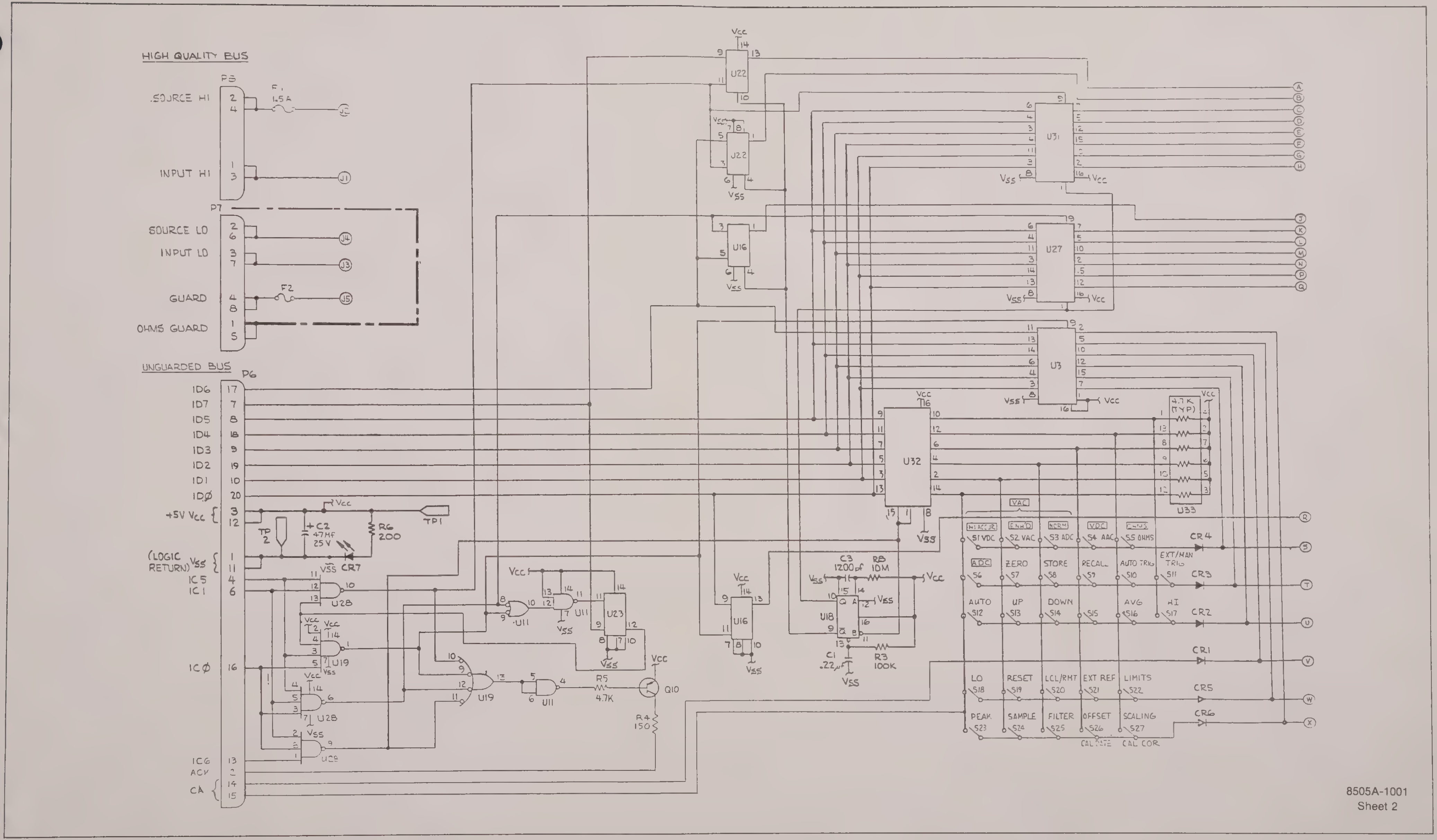
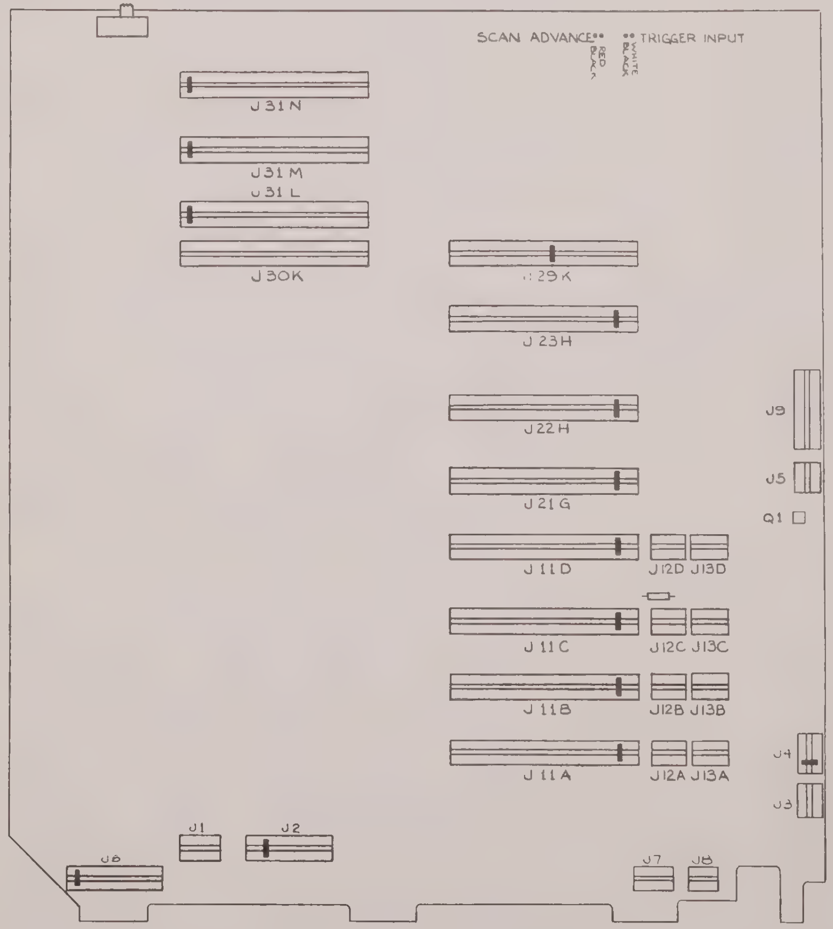

HIGH QUALITY BUS
P8
SOURCE HI
F1
1.5A
INPUT HI
P7
SOURCE LO
INPUT LO
GUARD
F2
OHMS GUARD
J1
J2
J3
J4
J5
UNGUARDED BUS
P6
ID6
ID7
ID5
ID4
ID3
ID2
ID1
ID0
+5V Vcc
(LOGIC RETURN) Vss
IC5
IC1
IC0
IC6
ACK
CA
TP1
TP2
C2
47MF
25V
R6
200
CR7
U28
U11
U23
U19
R5
4.7K
Q10
R4
150
U22
U16
U18
C3
1200pF
R8
10M
C1
.22μF
R3
100K
U31
U27
U3
U32
U33
4.7K (TYP)
Vcc
Vss
HI ACCUR
S1 VDC
ENH'D
S2 VAC
NORM
S3 ADC
VDC
S4 AAC
OHMS
S5 OHMS
VAC
ADC
S6
ZERO
S7
STORE
S8
RECALL
S9
AUTO TRIG
S10
EXT/MAN TRIG
S11
AUTO
S12
UP
S13
DOWN
S14
S15
AVG
S16
HI
S17
LO
S18
RESET
S19
LCL/RMT
S20
EXT REF
S21
LIMITS
S22
PEAK
S23
SAMPLE
S24
FILTER
S25
OFFSET
S26
SCALING
S27
CAL STEP
CAL COR
CR1
CR2
CR3
CR4
CR5
CR6
A
B
C
D
E
F
G
H
J
K
L
M
N
P
Q
R
S
T
U
V
W
X
8505A-1001
Sheet 2

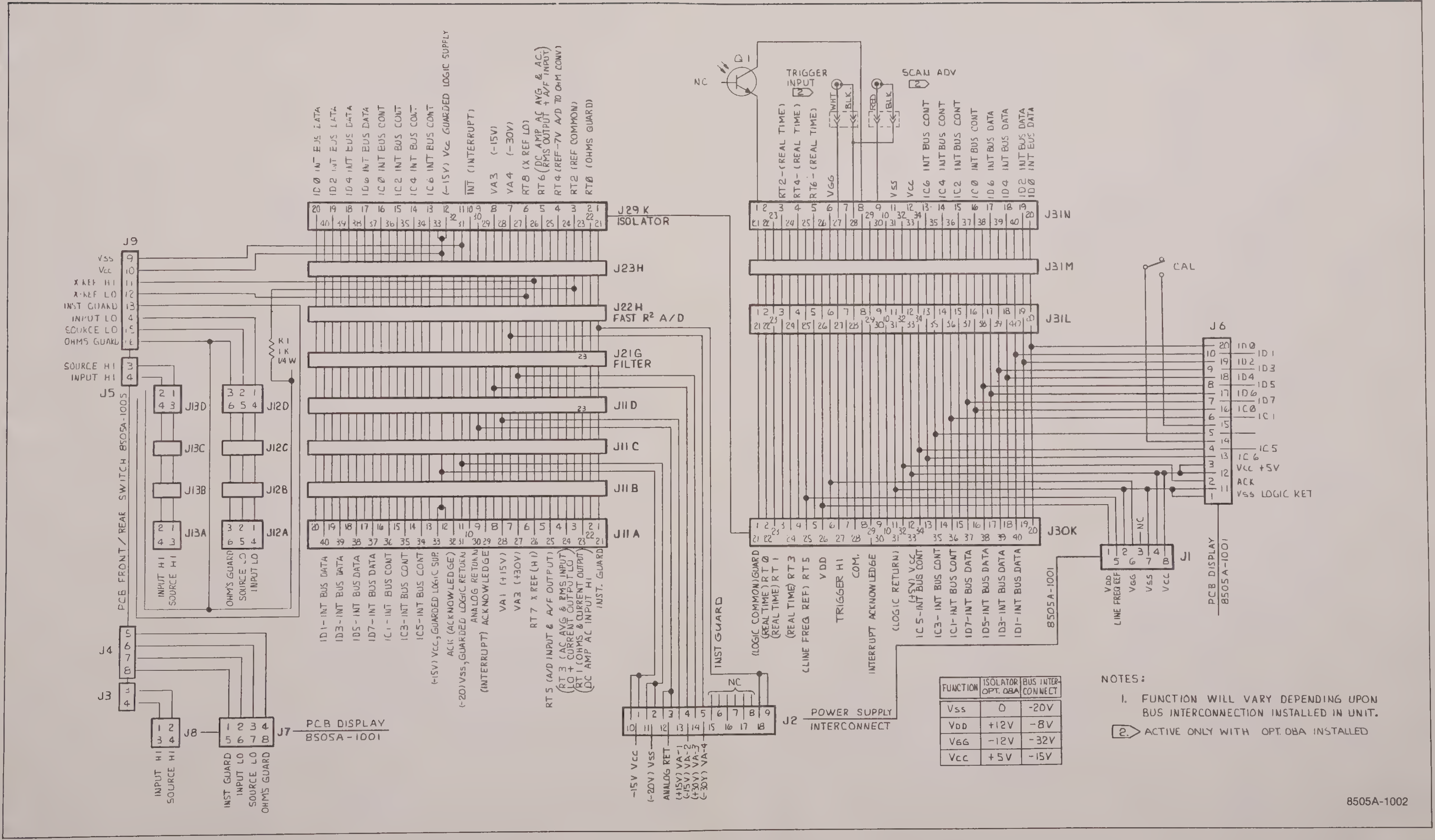
Figure 8-1. A1 Front Panel Display PCB Assembly (cont)

SLOT	8505 A	8506 A
N	-05, -06, OR -07	-05, -06, OR -07
M	CONTROLLER	CONTROLLER
L	CONTROLLER	CONTROLLER
K	-08A OR BUS INTERCONNECT	-08A OR BUS INTERCONNECT
H	A/D CONVERTER	A/D CONVERTER
H	A/D CONVERTER	A/D CONVERTER
G	ACTIVE FILTER	ACTIVE FILTER
D	-02, -03, -01, OR -09A**	THERMAL TRUE RMS CONVERTER
C	-02, -03, -01, OR -09A**	THERMAL TRUE RMS CONVERTER
B	-02, -03, -01, OR -09A**	-02 OR 03
A	DC SIGNAL CONDITIONER	DC SIGNAL


SCAN ADVANCE
RED
BLACK
WHITE
BLACK
TRIGGER INPUT
J31N
J31M
J31L
J30K
J29K
J23H
J22H
J21G
J11D
J12D
J13D
J11C
J12C
J13C
J11B
J12B
J13B
J11A
J12A
J13A
J9
J5
Q1
J4
J3
J1
J2
J6
J7
J8

8505A-1602

Figure 8-2. A2 Motherboard PCB Assembly


J29K ISOLATOR
J23H
J22H FAST R² A/D
J21G FILTER
J11D
J11C
J11B
J11A
J31N
J31M
J31L
J30K
J9
J5
J4
J3
J8
J7
PCB DISPLAY 8505A-1001
J2
POWER SUPPLY INTERCONNECT
J6
J1
J13D
J13C
J13B
J13A
J12D
J12C
J12B
J12A
R1 1K 1/4 W
Q1
NC
TRIGGER INPUT 2
SCAN ADV 2
WHT
BLK
RED
BLK
CAL
INST GUARD
PCB FRONT/REAR SWITCH 8505A-1005
PCB DISPLAY 8505A-1001
8505A-1001
Vss
Vcc
X REF HI
X REF LO
INST GUARD
INPUT LO
SOURCE LO
OHMS GUARD
SOURCE HI
INPUT HI
ID0 INT BUS DATA
ID2 INT BUS DATA
ID4 INT BUS DATA
ID6 INT BUS DATA
IC0 INT BUS CONT
IC2 INT BUS CONT
IC4 INT BUS CONT
IC6 INT BUS CONT
(-15V) Vcc GUARDED LOGIC SUPPLY
INT (INTERRUPT)
VA3 (-15V)
VA4 (-30V)
RT8 (X REF LO)
RT6 (DC AMP AC AVG & AC) (RMS OUTPUT + A/F INPUT)
RT4 (REF-7V A/D TO OHM CONV)
RT2 (REF COMMON)
RT0 (OHMS GUARD)
ID1-INT BUS DATA
ID3-INT BUS DATA
ID5-INT BUS DATA
ID7-INT BUS DATA
IC1-INT BUS CONT
IC3-INT BUS CONT
IC5-INT BUS CONT
(-15V) Vcc, GUARDED LOGIC SUP.
ACK (ACKNOWLEDGE)
(-20) Vss, GUARDED LOGIC RETURN
ANALOG RETURN
(INTERRUPT) ACKNOWLEDGE
VA1 (+15V)
VA3 (+30V)
RT7 X REF (HI)
RT5 (A/D INPUT & A/F OUTPUT)
RT3 (AC AVG & RMS INPUT) (LO + CURRENT OUTPUT LO)
RT1 (OHMS & CURRENT OUTPUT) (DC AMP AC INPUT HI)
INST. GUARD
RT2-(REAL TIME)
RT4-(REAL TIME)
RT6-(REAL TIME)
VGG
Vss
Vcc
IC6 INT BUS CONT
IC4 INT BUS CONT
IC2 INT BUS CONT
IC0 INT BUS CONT
ID6 INT BUS DATA
ID4 INT BUS DATA
ID2 INT BUS DATA
ID0 INT BUS DATA
(LOGIC COMMON) GUARD
(REAL TIME) RT0
(REAL TIME) RT1
(REAL TIME) RT3
(LINE FREQ REF) RT5
VDD
TRIGGER HI
COM.
INTERRUPT ACKNOWLEDGE
(LOGIC RETURN)
(+5V) Vcc
IC5-INT BUS CONT
IC3-INT BUS CONT
IC1-INT BUS CONT
ID7-INT BUS DATA
ID5-INT BUS DATA
ID3-INT BUS DATA
ID1-INT BUS DATA
ID0 ID1 ID2 ID3 ID4 ID5 ID6 ID7 IC0 IC1 IC5 IC6
Vcc +5V
ACK
Vss LOGIC RET
VDD
LINE FREQ REF
VGG
Vss
Vcc
NC
INPUT HI
SOURCE HI
INPUT HI
SOURCE HI
OHMS GUARD
SOURCE LO
INPUT LO
INST GUARD
INPUT LO
SOURCE LO
OHMS GUARD
-15V Vcc
(-20V) Vss
ANALOG RET
(+15V) VA-1
(-15V) VA-2
(+30V) VA-3
(-30V) VA-4
NC

FUNCTION	ISOLATOR OPT. 08A	BUS INTERCONNECT
Vss	0	-20V
VDD	+12V	-8V
VGG	-12V	-32V
Vcc	+5V	-15V

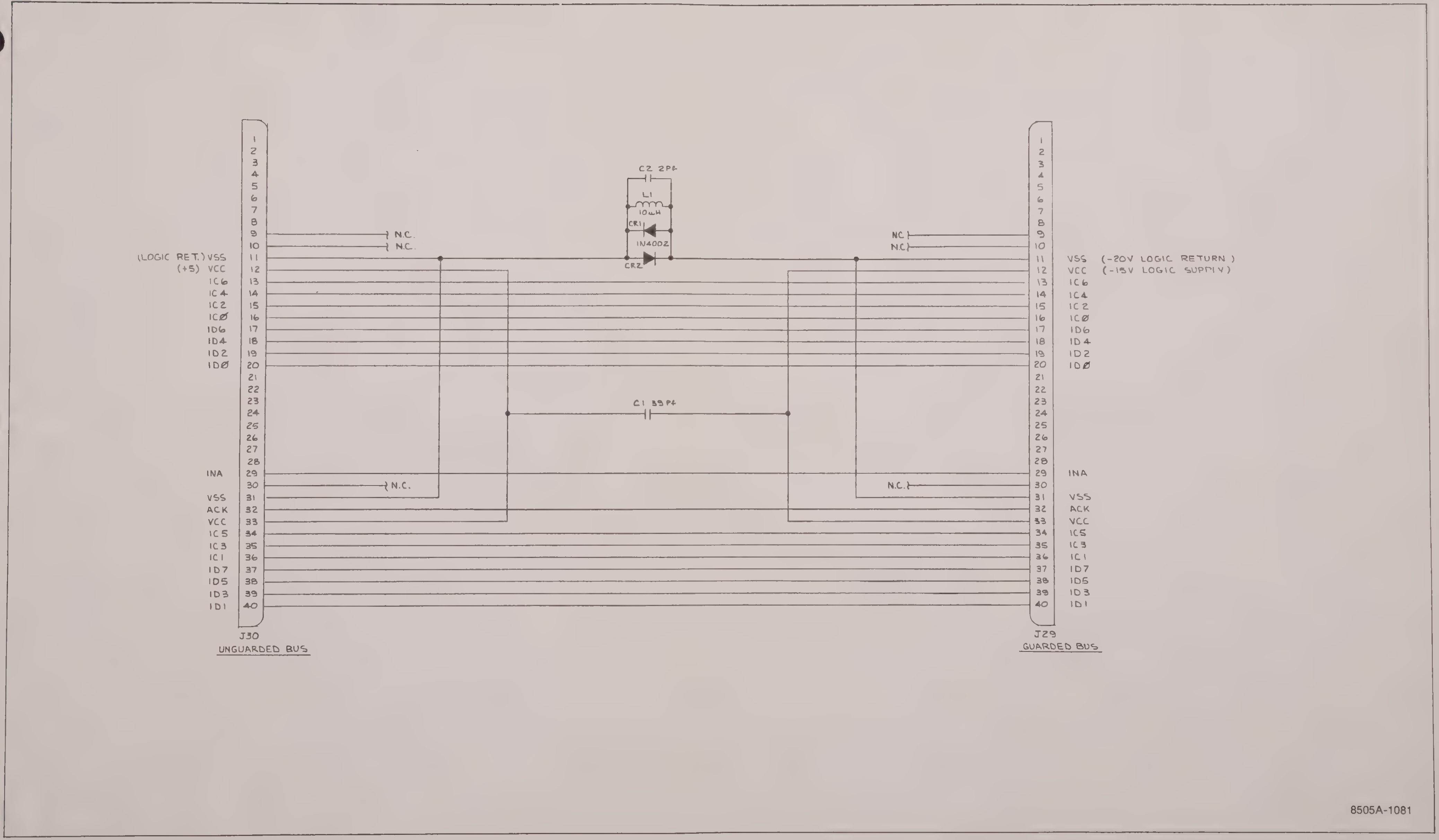
NOTES:

1. FUNCTION WILL VARY DEPENDING UPON BUS INTERCONNECTION INSTALLED IN UNIT.

2. ACTIVE ONLY WITH OPT. 08A INSTALLED

8505A-1002

Figure 8-2. A2 Motherboard PCB Assembly (cont)



(LOGIC RET.) VSS
(+5) VCC
IC6
IC4
IC2
IC0
ID6
ID4
ID2
ID0
INA
VSS
ACK
VCC
IC5
IC3
IC1
ID7
ID5
ID3
ID1
N.C.
N.C.
N.C.
C2 2PF
L1 10uH
CR1
1N4002
CR2
C1 39PF
NC
N.C.
N.C.
VSS (-20V LOGIC RETURN)
VCC (-15V LOGIC SUPPLY)
J30
UNGUARDED BUS
J29
GUARDED BUS
8505A-1081

Figure 8-3. A3 Bus Interconnect

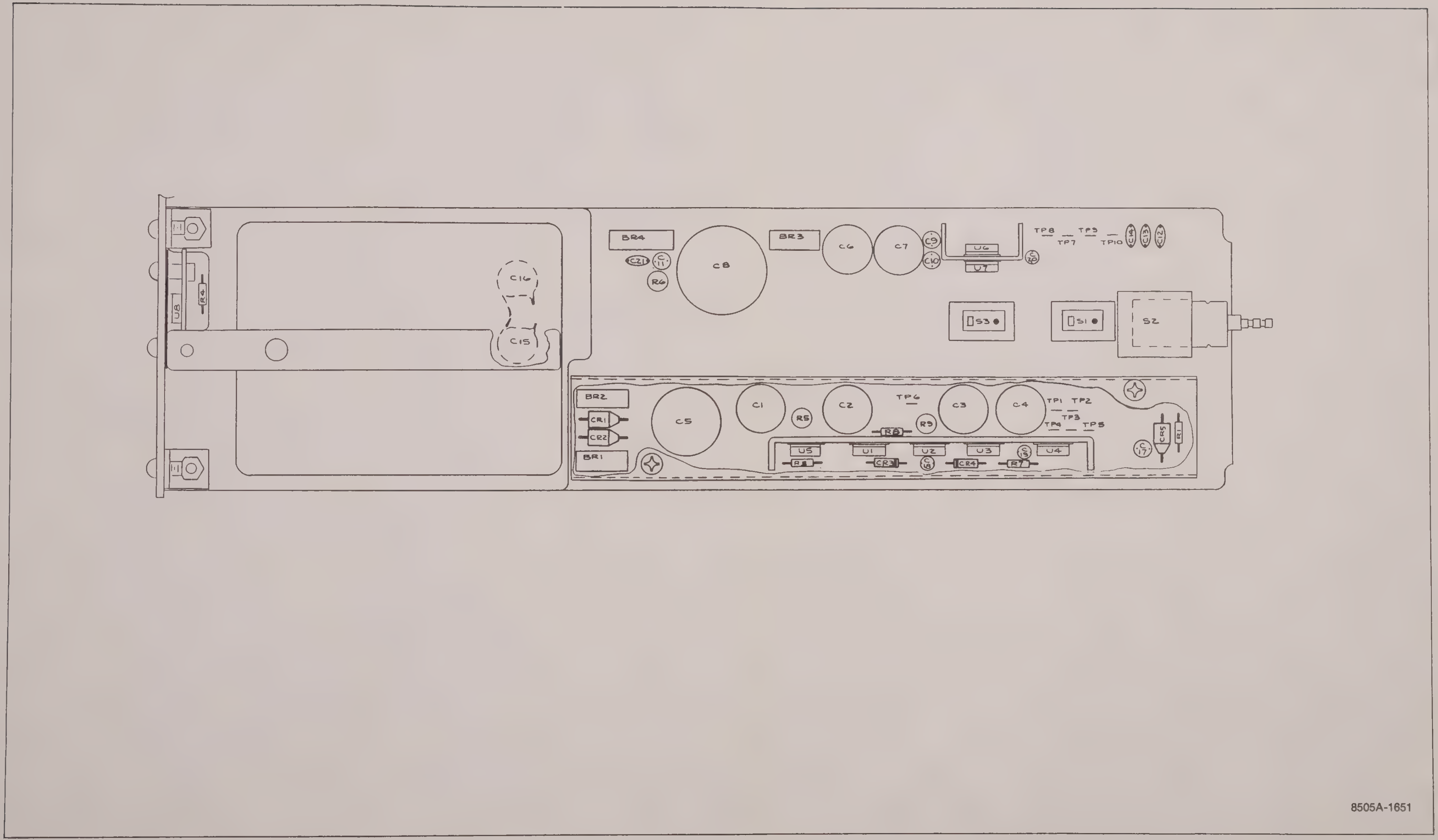

BR4
BR3
C8
C6
C7
C9
C10
U6
U7
C20
C21
C11
R6
TP8
TP9
TP7
TP10
C14
C13
C12
C16
C15
R4
U8
S3
S1
S2
BR2
C5
C1
R5
C2
TP6
R8
R9
C3
C4
TP1
TP2
TP3
TP4
TP5
CR1
CR2
BR1
U5
U1
U2
U3
C19
U4
R3
CR3
C18
CR4
R7
CR5
R1
C17
8505A-1651

Figure 8-4. A4 Power Supply PCB Assembly

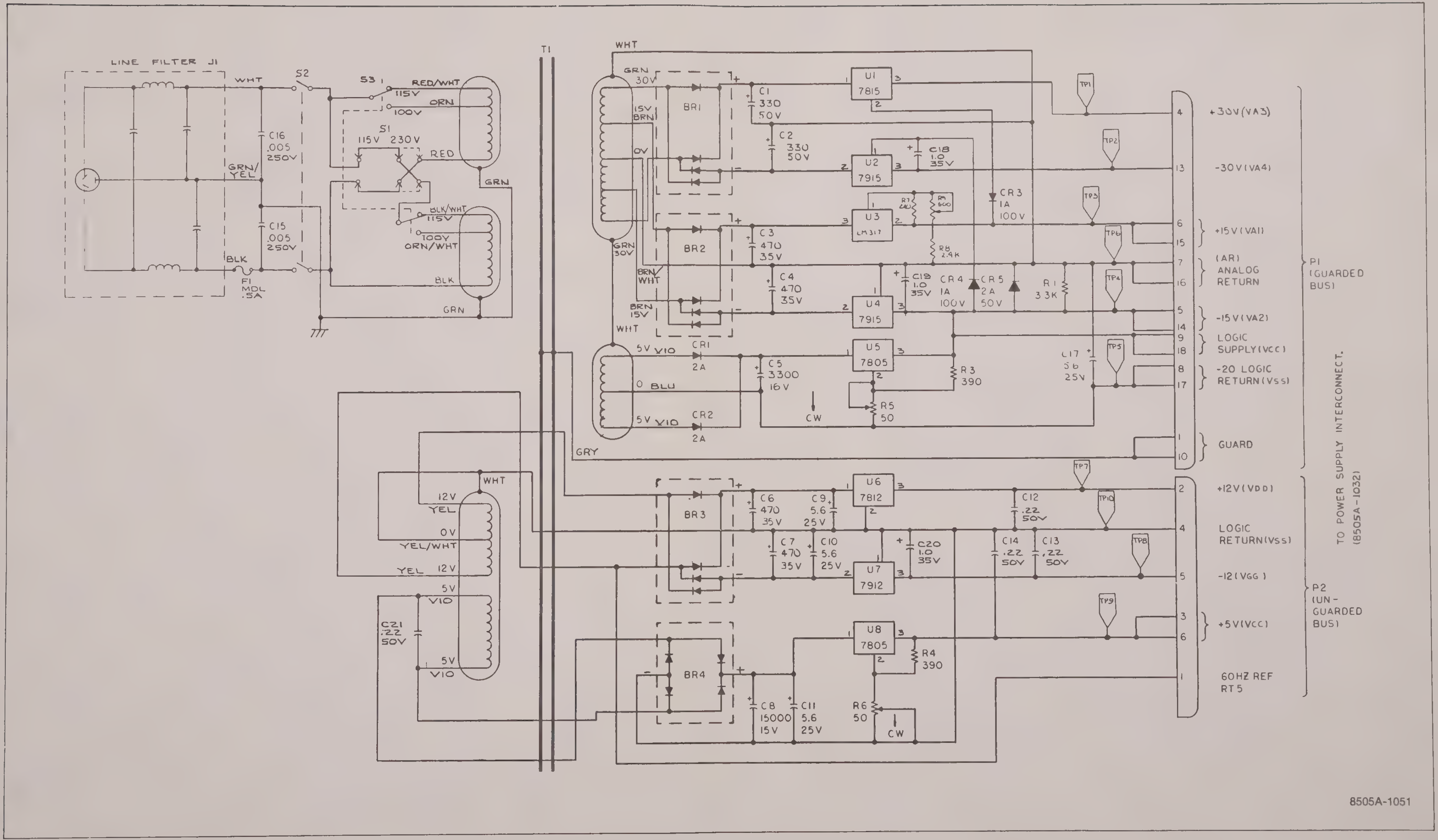
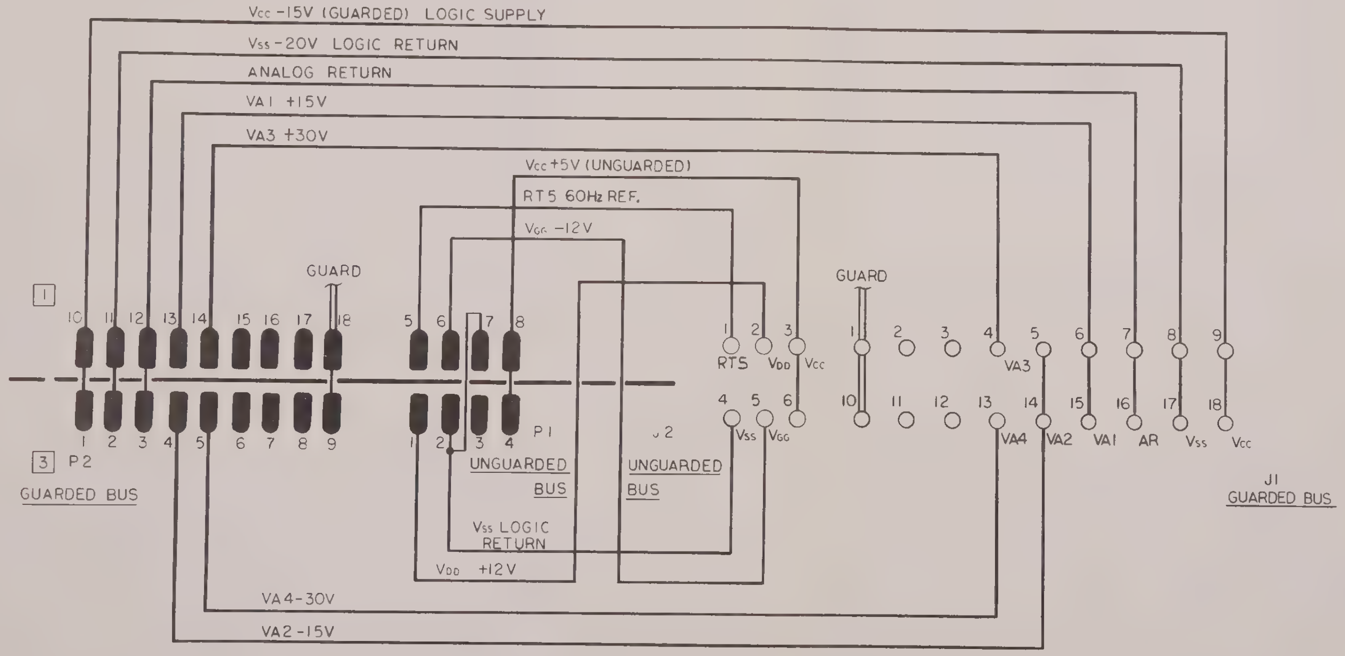

LINE FILTER J1
WHT
S2
S3
115V
RED/WHT
ORN
100V
S1
115V 230V
RED
GRN
C16 .005 250V
GRN/YEL
C15 .005 250V
BLK/WHT
115V
100V
ORN/WHT
BLK
F1 MDL .5A
BLK
GRN
T1
WHT
GRN 30V
15V BRN
0V
GRN 30V
BRN/WHT
BRN 15V
WHT
BR1
BR2
C1 330 50V
C2 330 50V
C3 470 35V
C4 470 35V
U1 7815
U2 7915
U3 LM317
U4 7915
C18 1.0 35V
R7
R9 500
R8 2.4K
CR3 1A 100V
C19 1.0 35V
CR4 1A 100V
CR5 2A 50V
R1 3.3K
TP1
TP2
TP3
TP6
TP4
5V VIO
0 BLU
5V VIO
CR1 2A
CR2 2A
C5 3300 16V
U5 7805
R3 390
R5 50
CW
C17 56 25V
TP5
GRY
+30V (VA3)
-30V (VA4)
+15V (VA1)
(AR) ANALOG RETURN
-15V (VA2)
LOGIC SUPPLY (VCC)
-20 LOGIC RETURN (VSS)
GUARD
P1 (GUARDED BUS)
4
13
6
15
7
16
5
14
9
18
8
17
1
10
WHT
12V YEL
0V YEL/WHT
YEL 12V
5V VIO
5V VIO
C21 .22 50V
BR3
C6 470 35V
C9 5.6 25V
C7 470 35V
C10 5.6 25V
U6 7812
U7 7912
C20 1.0 35V
C12 .22 50V
C14 .22 50V
C13 .22 50V
TP7
TP10
TP8
TP9
BR4
C8 15000 15V
C11 5.6 25V
U8 7805
R4 390
R6 50
CW
+12V (VDD)
LOGIC RETURN (VSS)
-12 (VGG)
+5V (VCC)
60HZ REF RT5
2
4
5
3
6
1
P2 (UN-GUARDED BUS)
TO POWER SUPPLY INTERCONNECT. (8505A-1032)
8505A-1051

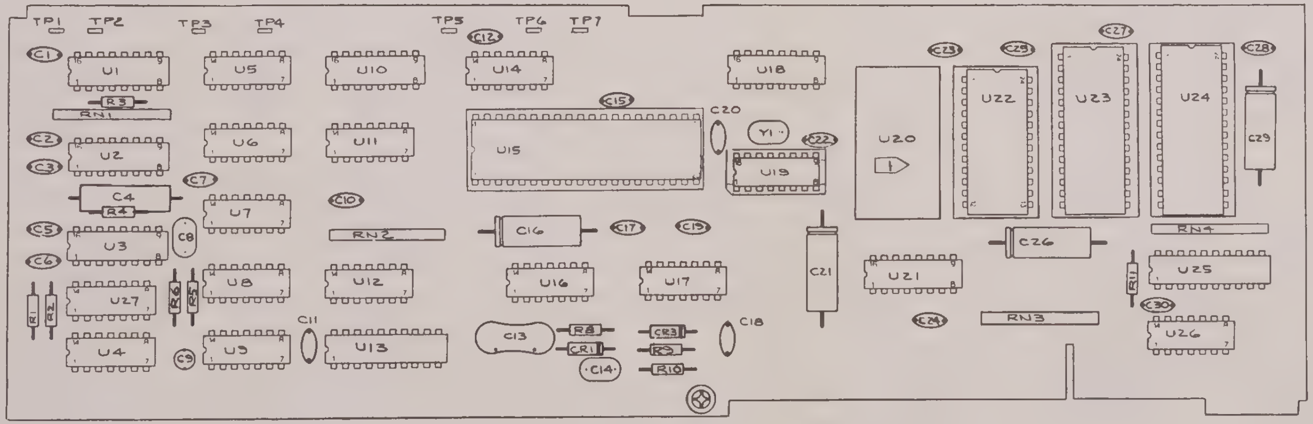
Figure 8-4. A4 Power Supply PCB Assembly (cont)

)


Vcc -15V (GUARDED) LOGIC SUPPLY
Vss -20V LOGIC RETURN
ANALOG RETURN
VA1 +15V
VA3 +30V
Vcc +5V (UNGUARDED)
RT5 60Hz REF.
VGG -12V
GUARD
1
10 11 12 13 14 15 16 17 18
1 2 3 4 5 6 7 8 9
3 P2
GUARDED BUS
5 6 7 8
1 2 3 4
P1
UNGUARDED BUS
J2
UNGUARDED BUS
Vss LOGIC RETURN
VDD +12V
VA4 -30V
VA2 -15V
1 2 3
RTS VDD Vcc
4 5 6
Vss VGG
GUARD
1 2 3 4 5 6 7 8 9
VA3
10 11 12 13 14 15 16 17 18
VA4 VA2 VA1 AR Vss Vcc
J1
GUARDED BUS

8505A-1332

Figure 8-5. A5 Power Supply Interconnect


TP1
TP2
TP3
TP4
TP5
TP6
TP7
C12
C27
C23
C25
C28
C1
U1
U5
U10
U14
U18
U22
U23
U24
R3
RN1
C15
C20
U15
Y1
C22
U20
C29
C2
U2
U6
U11
U19
C3
C7
C4
C10
R4
U7
C5
C8
RN2
C16
C17
C19
RN4
U3
C21
U21
C26
R11
U25
C6
U27
R6
R5
U8
U12
U16
U17
R1
R2
C11
C18
C24
RN3
C30
U26
U4
C9
U9
U13
C13
R8
CR1
CR3
R9
C14
R10

MIS-1687

Figure 8-6. A6 Controller PCB Assembly

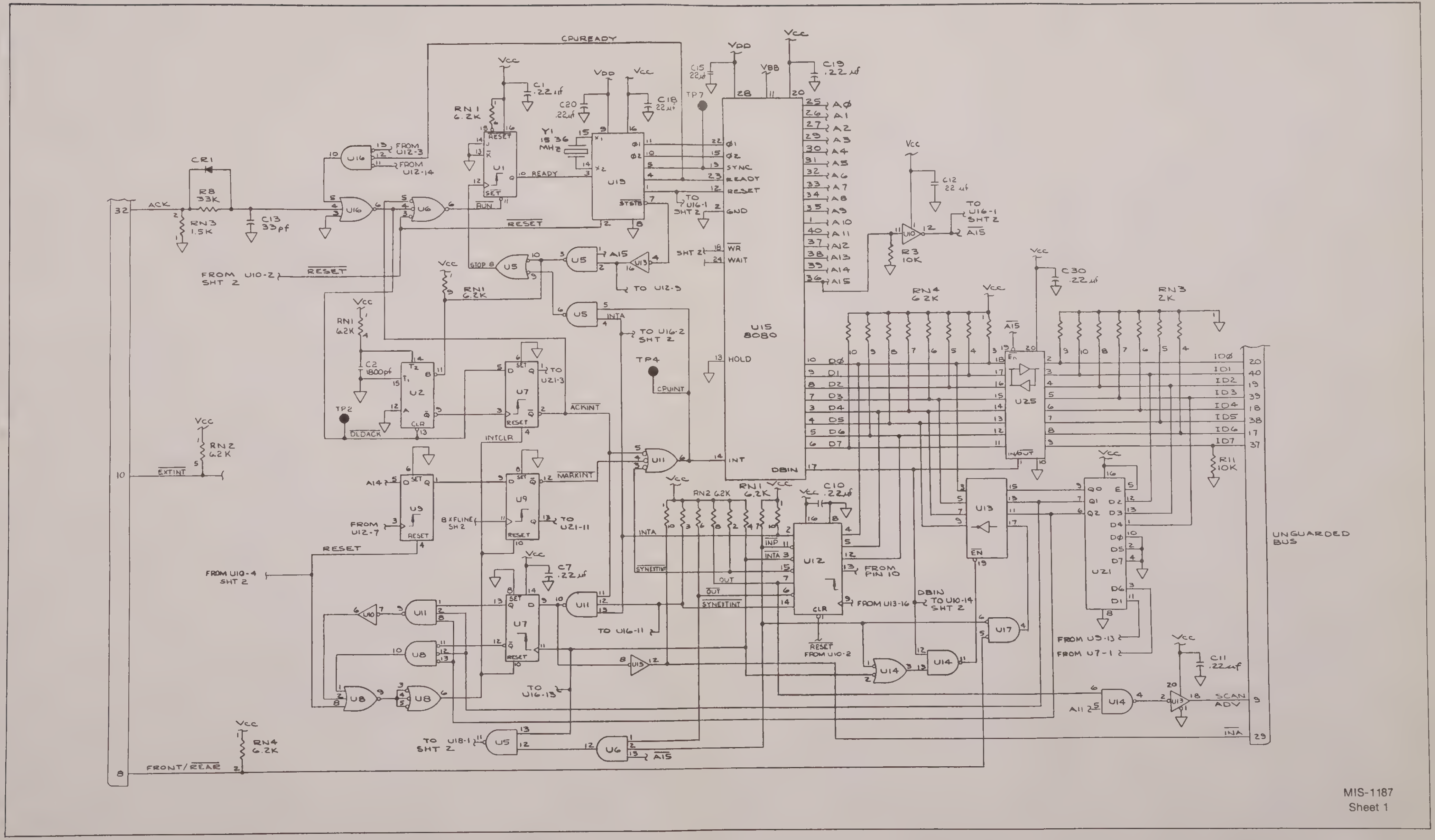

CPUREADY
Vcc
Vdd
Vbb
C1 .22 µf
C15 22 µf
C19 .22 µf
C18 22 µf
C20 .22 µf
TP7
RN1 6.2K
Y1 15.36 MHz
U1
READY
SET
RUN
RESET
U19
Ø1
Ø2
SYNC
READY
RESET
GND
STSTB
TO U16-1 SHT 2
WR
WAIT
SHT 2
HOLD
INT
DBIN
U15 8080
A0
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
A12
A13
A14
A15
D0
D1
D2
D3
D4
D5
D6
D7
CR1
R8 33K
ACK
RN3 1.5K
C13 33pf
U16
FROM U12-3
FROM U12-14
U6
FROM U10-2 SHT 2
STOP 8
U5
U13
TO U12-9
INTA
TO U16-2 SHT 2
TP4
CPUINT
RN1 6.2K
C2 1800pf
U2
TP2
OLDACK
U7
TO U21-3
ACKINT
INTCLR
U11
U9
A14
FROM U12-7
MARKINT
8XFLINE SH 2
TO U21-11
RESET
FROM U10-4 SHT 2
RN2 6.2K
EXTINT
C7 .22 µf
U10
U8
TO U16-11
TO U16-13
TO U18-1 SHT 2
RN4 6.2K
FRONT/REAR
INTA
SYNEXTINT
OUT
RN2 6.2K
RN1 6.2K
C10 .22 µf
INP
U12
CLR
FROM PIN 10
FROM U13-16
DBIN
TO U10-14 SHT 2
RESET FROM U10-2
U17
U14
C12 .22 µf
R3 10K
TO U16-1 SHT 2
A15
RN4 6.2K
C30 .22 µf
RN3 2K
U25
En
IN/OUT
ID0
ID1
ID2
ID3
ID4
ID5
ID6
ID7
R11 10K
UNGUARDED BUS
EN
U21
Q0
Q1
Q2
E
D2
D3
D4
D0
D5
D7
D6
D1
FROM U5-13
FROM U7-1
C11 .22 µf
A11
SCAN ADV
INA
MIS-1187
Sheet 1

Figure 8-6. A6 Controller PCB Assembly (cont)

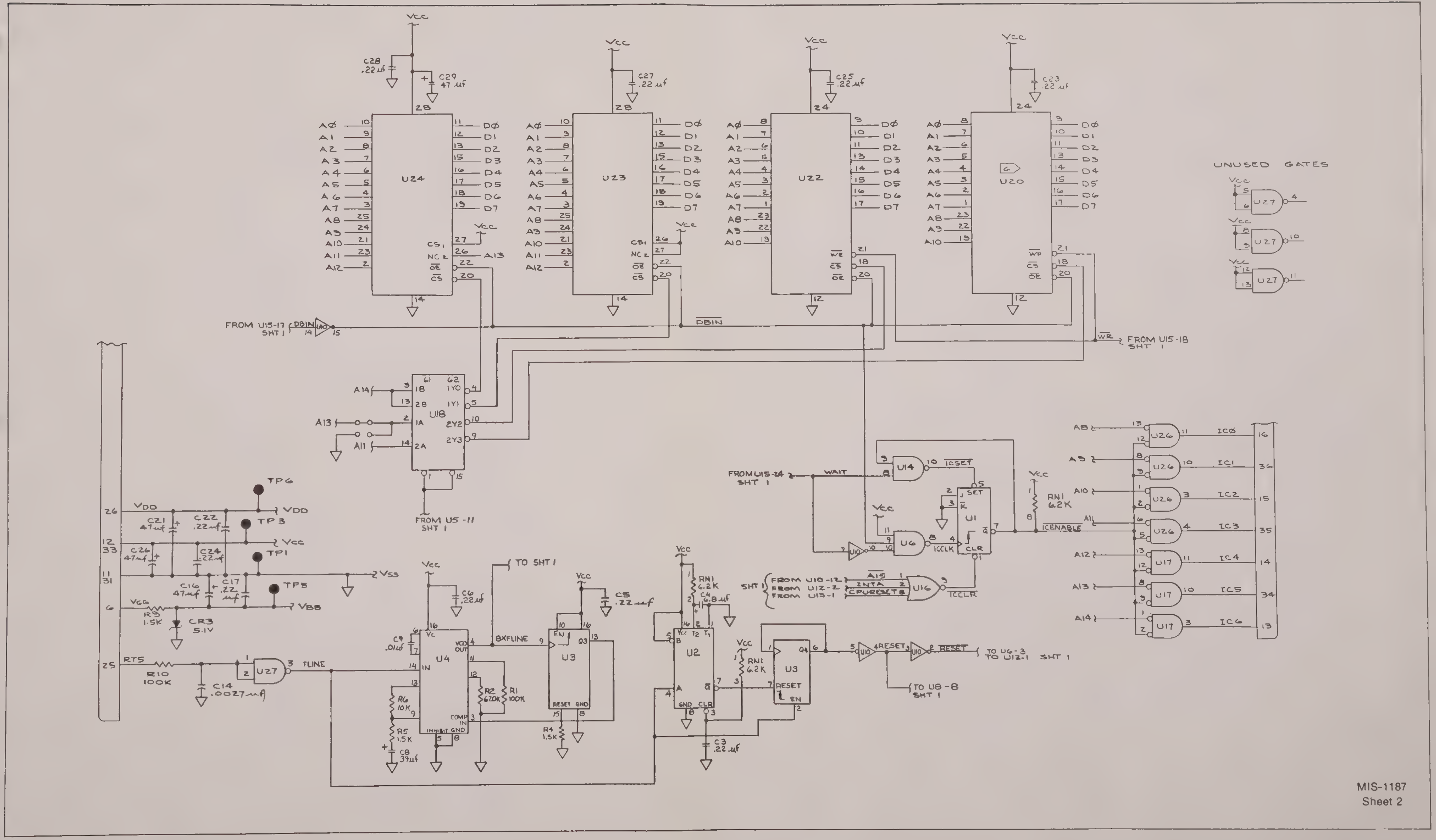
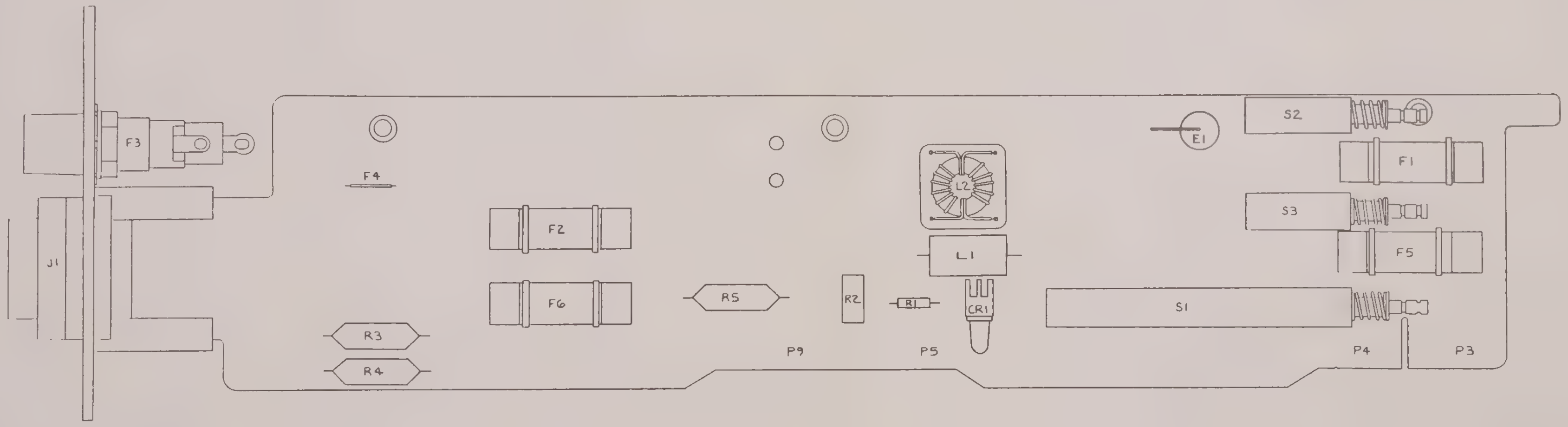

U24
U23
U22
U20
Vcc
C28 .22µf
C29 47µf
C27 .22µf
C25 .22µf
C23 .22µf
A0 A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11 A12
D0 D1 D2 D3 D4 D5 D6 D7
CS1
NC2
OE
CS
WE
A13
UNUSED GATES
U27
FROM U15-17 SHT 1
DBIN
U10
DBIN
WR
FROM U15-18 SHT 1
A14
A13
A11
U18
1B 2B 1A 2A
1Y0 1Y1 2Y2 2Y3
G1 G2
FROM U5-11 SHT 1
TP6
TP3
TP1
TP5
VDD
C21 47µf
C22 .22µf
C26 47µf
C24 .22µf
C16 47µf
C17 .22µf
Vcc
VSS
VGG
VBB
R9 1.5K
CR3 5.1V
RT5
R10 100K
C14 .0027µf
FLINE
TO SHT 1
BXFLINE
C9 .01µf
U4
R6 10K
R5 1.5K
C8 39µf
R2 620K
R1 100K
C6 .22µf
U3
C5 .22µf
R4 1.5K
RN1 6.2K
C4 6.8µf
U2
C3 .22µf
RN1 6.2K
U3
RESET
RESET
TO U6-3
TO U12-1 SHT 1
TO U8-8 SHT 1
FROM U15-24 SHT 1
WAIT
U14
ICSET
U1
U6
ICCLK
ICENABLE
RN1 6.2K
SHT 1
FROM U10-12
FROM U12-2
FROM U13-1
AIS
INTA
CPURESET
U16
ICCLR
A8 A9 A10 A11 A12 A13 A14
U26
U17
IC0 IC1 IC2 IC3 IC4 IC5 IC6
16 36 15 35 14 34 13
26 12 33 11 31 6 25
MIS-1187
Sheet 2

Figure 8-6. A6 Controller PCB Assembly (cont)


F3
J1
F4
F2
F6
R3
R4
R5
P9
R2
R1
CR1
P5
L2
L1
E1
S2
F1
S3
F5
S1
P4
P3

8505A-1605

Figure 8-7. A7 Front/Rear Switch Assembly

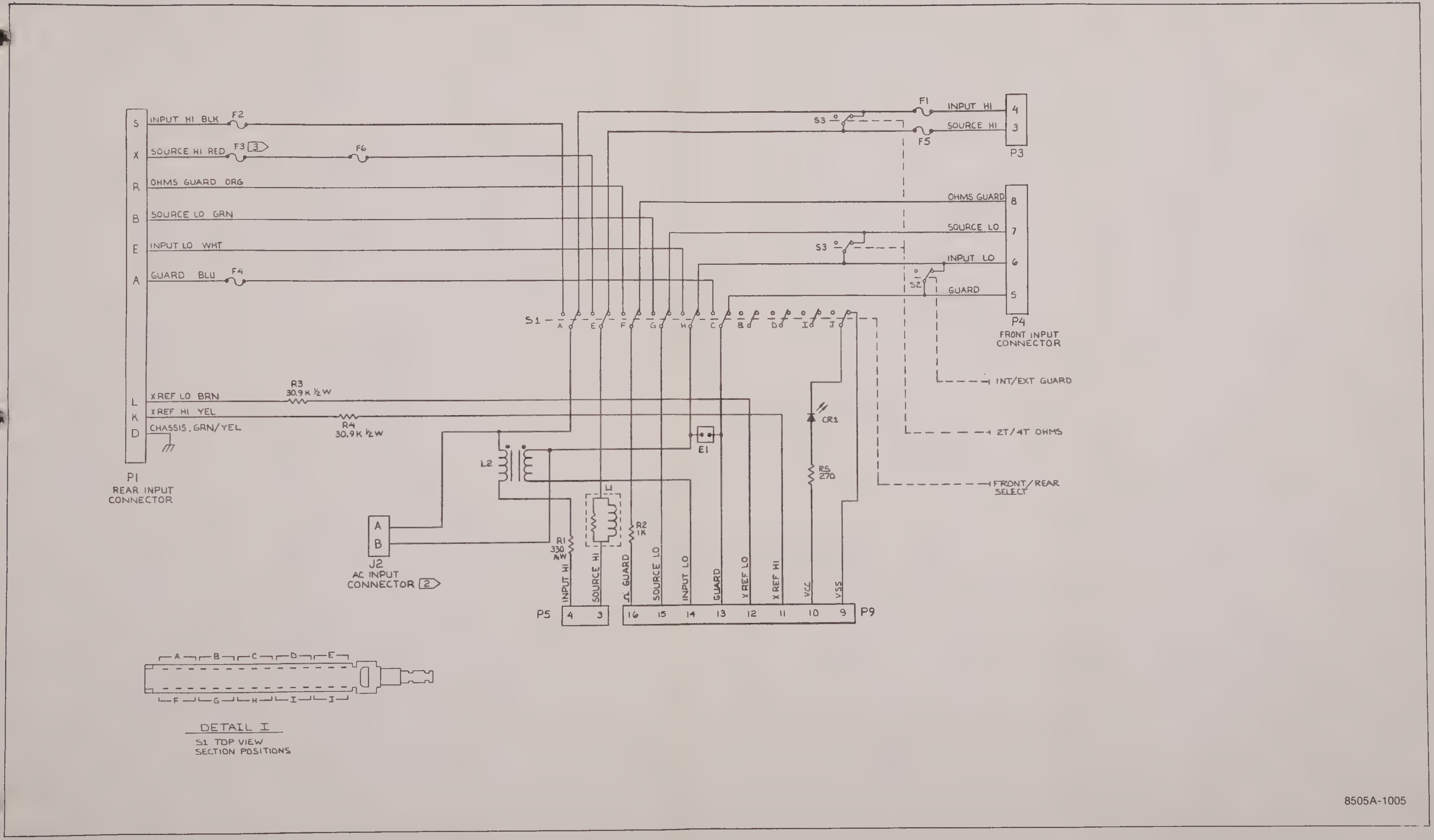

P1
REAR INPUT CONNECTOR
S
X
R
B
E
A
L
K
D
INPUT HI BLK
SOURCE HI RED
OHMS GUARD ORG
SOURCE LO GRN
INPUT LO WHT
GUARD BLU
XREF LO BRN
XREF HI YEL
CHASSIS, GRN/YEL
F2
F3
3
F6
F4
R3
30.9K ½W
R4
30.9K ½W
S1
A
E
F
G
H
C
B
D
I
J
F1
F5
S3
S2
INPUT HI
SOURCE HI
4
3
P3
OHMS GUARD
SOURCE LO
INPUT LO
GUARD
8
7
6
5
P4
FRONT INPUT CONNECTOR
INT/EXT GUARD
2T/4T OHMS
FRONT/REAR SELECT
L2
L1
E1
CR1
R5
270
R1
330
½W
R2
1K
A
B
J2
AC INPUT CONNECTOR
2
INPUT HI
SOURCE HI
Ω GUARD
SOURCE LO
INPUT LO
GUARD
X REF LO
X REF HI
VCC
VSS
P5
4
3
16
15
14
13
12
11
10
9
P9
A
B
C
D
E
F
G
H
I
J
DETAIL I
S1 TOP VIEW
SECTION POSITIONS
8505A-1005

Figure 8-7. A7 Front/Rear Switch Assembly (cont)

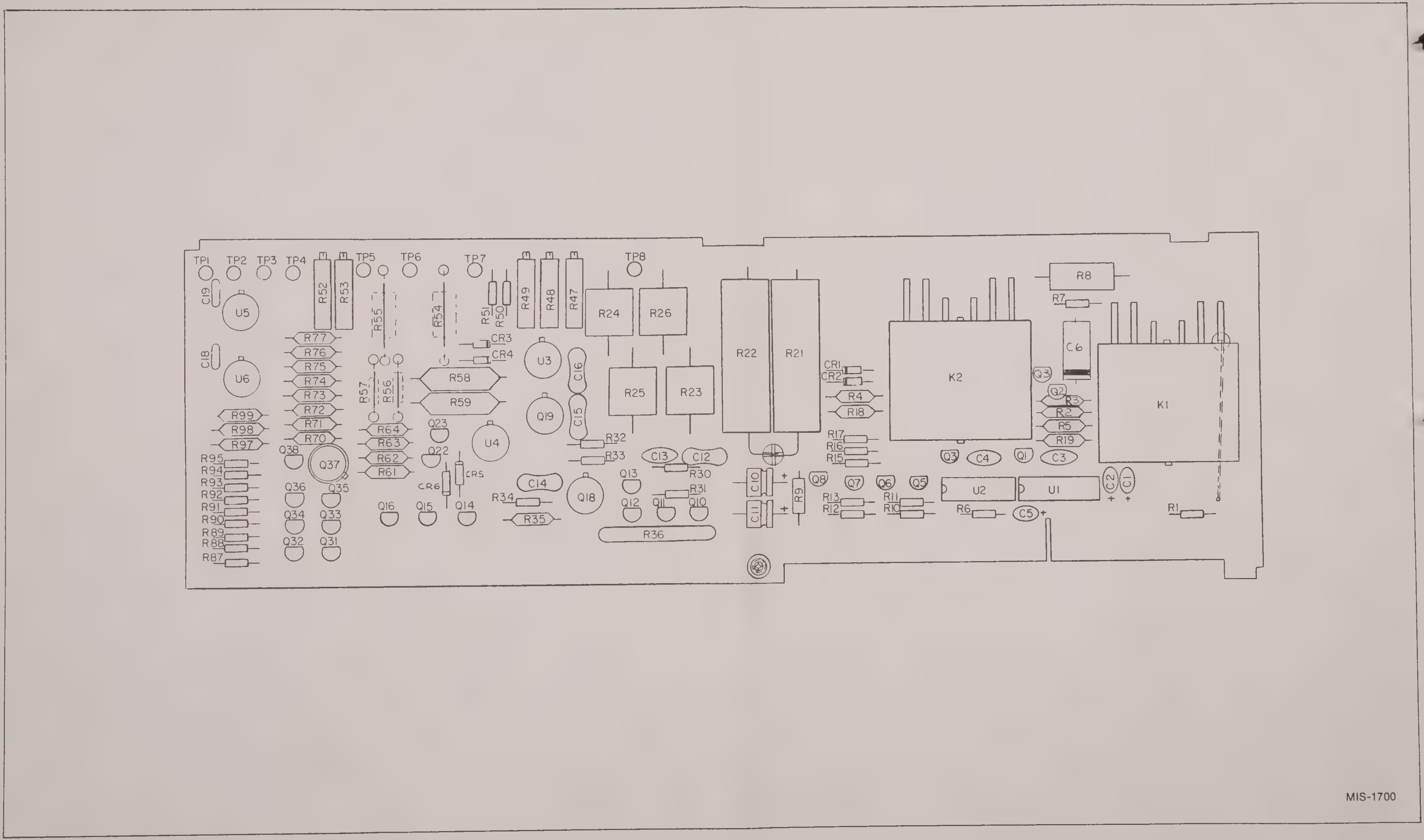
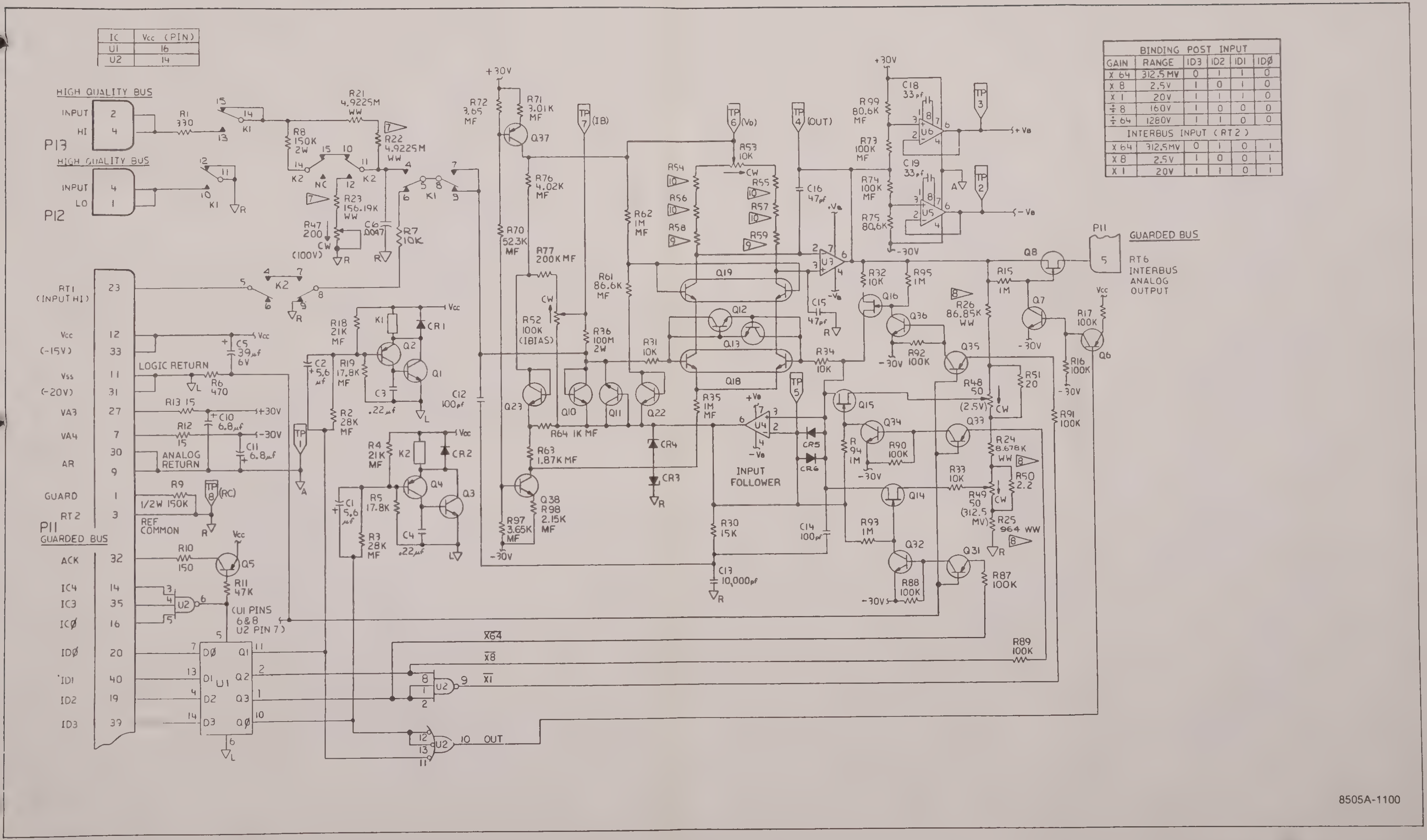

TP1
TP2
TP3
TP4
TP5
TP6
TP7
TP8
C19
U5
C18
U6
R52
R53
R55
R54
R51
R50
R49
R48
R47
R24
R26
R22
R21
R8
R7
C6
K2
K1
R77
R76
R75
R74
R73
R72
R71
R70
R99
R98
R97
R57
R56
R58
R59
CR3
CR4
U3
C16
C15
Q19
U4
R25
R23
CR1
CR2
R4
R18
Q3
Q2
R3
R2
R5
R19
R64
R63
R62
R61
Q23
Q22
Q38
Q37
R95
R94
R93
R92
R91
R90
R89
R88
R87
Q36
Q35
Q34
Q33
Q32
Q31
Q16
Q15
Q14
CR6
CR5
R32
R33
C13
C12
R30
R31
C14
Q18
R34
R35
Q13
Q12
Q11
Q10
R36
C10
C11
R9
Q8
Q7
Q6
Q5
R17
R16
R15
R13
R12
R11
R10
Q3
C4
Q1
C3
U2
U1
C2
C1
R6
C5
R1
MIS-1700

Figure 8-8. A8 DC Signal Conditioner PCB Assembly

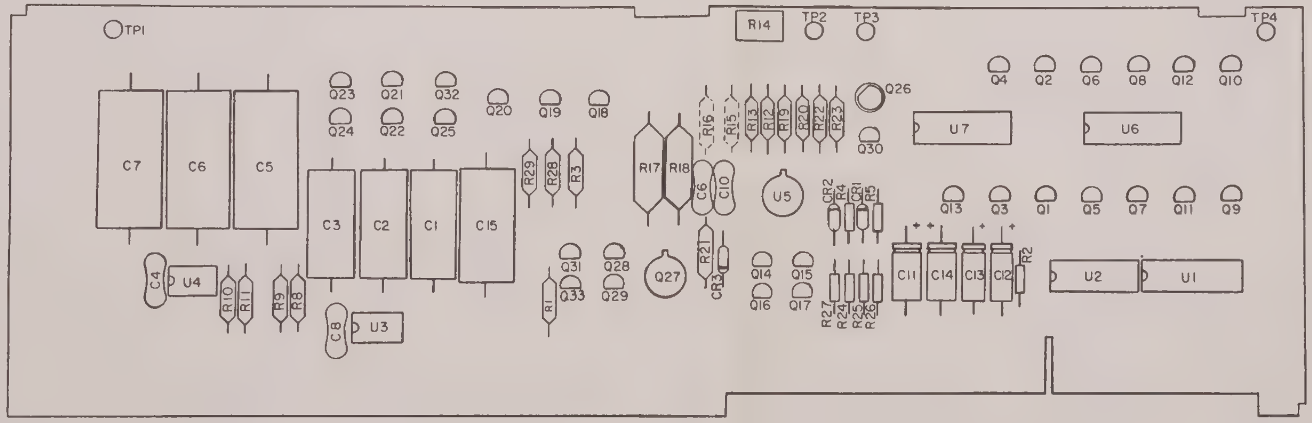


IC	Vcc (PIN)
U1	16
U2	14

BINDING POST INPUT					
GAIN	RANGE	ID3	ID2	ID1	ID0
X 64	312.5MV	0	1	1	0
X 8	2.5V	1	0	1	0
X 1	20V	1	1	1	0
÷ 8	160V	1	0	0	0
÷ 64	1280V	1	1	0	0
INTERBUS INPUT (RT2)					
X 64	312.5MV	0	1	0	1
X 8	2.5V	1	0	0	1
X 1	20V	1	1	0	1

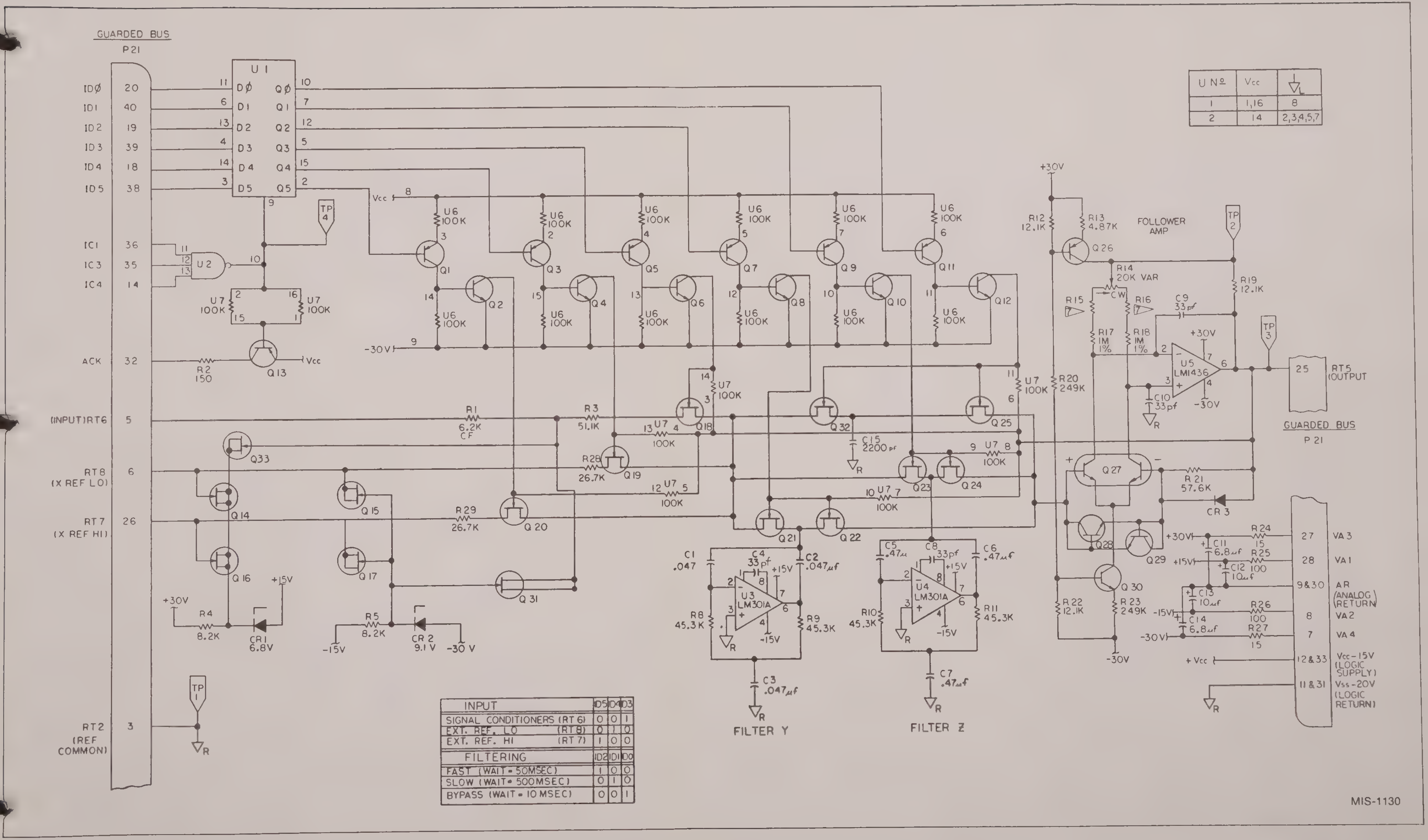
HIGH QUALITY BUS
INPUT
HI
P13
HIGH QUALITY BUS
INPUT
LO
P12
R1 330
K1
R21 4.9225M WW
R22 4.9225M WW
R8 150K 2W
K2
NC
R23 156.19K WW
R47 200
CW
(100V)
C6 .0047
R7 10K
RT1 (INPUT HI)
Vcc
(-15V)
Vss
(-20V)
VA3
VA4
AR
GUARD
RT2
P11
GUARDED BUS
ACK
IC4
IC3
IC0
ID0
ID1
ID2
ID3
LOGIC RETURN
C5 39µf 6V
R6 470
R13 15
C10 6.8µf
R12 15
C11 6.8µf
ANALOG RETURN
R9 1/2W 150K
TP 8 (RC)
REF COMMON
R10 150
Q5
R11 47K
U2
U1
(U1 PINS 6&8 U2 PIN 7)
X64
X8
X1
OUT
R18 21K MF
R19 17.8K MF
C2 5.6µf
C3 .22µf
Q1
Q2
CR1
TP 1
R2 28K MF
R4 21K MF
R5 17.8K
R3 28K MF
C1 5.6µf
C4 .22µf
Q3
Q4
CR2
C12 100pf
+30V
R72 3.65 MF
R71 3.01K MF
Q37
R76 4.02K MF
R70 52.3K MF
R77 200K MF
R52 100K (IBIAS)
R36 100M 2W
Q23
Q10
Q11
Q22
R64 1K MF
R63 1.87K MF
Q38
R97 3.65K MF
R98 2.15K MF
-30V
TP 7 (IB)
TP 6 (Vo)
TP 4 (OUT)
R53 10K
R54
R55
R56
R57
R58
R59
R62 1M MF
R61 86.6K MF
R31 10K
Q19
Q12
Q13
Q18
R34 10K
R35 1M MF
CR4
CR3
C16 47pf
U3
C15 47pf
TP 5
U4
INPUT FOLLOWER
CR5
CR6
R30 15K
C14 100pf
C13 10,000pf
R99 80.6K MF
R73 100K MF
R74 100K MF
R75 80.6K
C18 33pf
C19 33pf
U6
U5
TP 3
TP 2
+Vs
-Vs
R32 10K
R95 1M
Q16
Q36
R92 100K
Q35
Q15
Q34
R94 1M
R90 100K
Q33
Q14
R93 1M
Q32
R88 100K
Q31
R87 100K
R26 86.85K WW
R15 1M
Q8
Q7
R17 100K
Q6
R16 100K
R51 20
R48 50 (2.5V)
R91 100K
R24 8.678K WW
R33 10K
R50 2.2
R49 50 (312.5 MV)
R25 964 WW
R89 100K
P11
GUARDED BUS
RT6 INTERBUS ANALOG OUTPUT
8505A-1100

Figure 8-8. A8 DC Signal Conditioner PCB Assembly (cont)


TP1
R14
TP2
TP3
TP4
Q4
Q2
Q6
Q8
Q12
Q10
Q23
Q21
Q32
Q20
Q19
Q18
Q24
Q22
Q25
R16
R15
R13
R12
R19
R20
R22
R23
Q26
Q30
U7
U6
C7
C6
C5
R29
R28
R3
R17
R18
C9
C10
U5
CR2
R4
CR1
R5
Q13
Q3
Q1
Q5
Q7
Q11
Q9
C3
C2
C1
C15
Q31
Q28
Q33
Q29
Q27
R21
CR3
Q14
Q15
Q16
Q17
R27
R24
R25
R26
C11
C14
C13
C12
R2
U2
U1
C4
U4
R10
R11
R9
R8
R1
C8
U3

MIS-1730

Figure 8-9. A9 Active Filter PCB Assembly


GUARDED BUS
P21
IDØ 20
ID1 40
ID2 19
ID3 39
ID4 18
ID5 38
IC1 36
IC3 35
IC4 14
ACK 32
(INPUT)RT6 5
RT8 (X REF LO) 6
RT7 (X REF HI) 26
RT2 (REF COMMON) 3
U1
DØ QØ
D1 Q1
D2 Q2
D3 Q3
D4 Q4
D5 Q5
U2
TP 4
TP 1
U7 100K
R2 150
Q13
Vcc
Vcc 8
U6 100K
Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q12
-30V 9
R1 6.2K CF
R3 51.1K
U7 100K
Q18
Q19
R28 26.7K
R29 26.7K
Q20
Q14
Q15
Q16
Q17
Q31
Q33
Q32
Q25
C15 2200pf
Q23
Q24
Q21
Q22
+30V
R4 8.2K
CR1 6.8V
+15V
-15V
R5 8.2K
CR2 9.1 V
-30 V
C1 .047
C4 33pf
C2 .047µf
U3 LM301A
R8 45.3K
R9 45.3K
C3 .047µf
FILTER Y
C5 .47µ
C8 33pf
C6 .47µf
U4 LM301A
R10 45.3K
R11 45.3K
C7 .47µf
FILTER Z
+30V
R12 12.1K
R13 4.87K
Q26
FOLLOWER AMP
R14 20K VAR
CW
R15
R16
R17 1M 1%
R18 1M 1%
C9 33pf
C10 33pf
U5 LM1436
TP 2
TP 3
R19 12.1K
R20 249K
25 RT5 (OUTPUT)
GUARDED BUS
P 21
Q27
R21 57.6K
CR3
Q28
Q29
Q30
R22 12.1K
R23 249K
-30V
C11 6.8µf
C12 10µf
C13 10µf
C14 6.8µf
R24 15
R25 100
R26 100
R27 15
27 VA3
28 VA1
9&30 AR (ANALOG RETURN)
8 VA2
7 VA4
12&33 Vcc-15V (LOGIC SUPPLY)
11&31 Vss-20V (LOGIC RETURN)
+Vcc
R
MIS-1130

U Nº	Vcc	▽L
1	1,16	8
2	14	2,3,4,5,7

INPUT	ID5	ID4	ID3
SIGNAL CONDITIONERS (RT 6)	0	0	1
EXT. REF. LO (RT 8)	0	1	0
EXT. REF. HI (RT 7)	1	0	0
FILTERING	**ID2**	**ID1**	**ID0**
FAST (WAIT = 50MSEC)	1	0	0
SLOW (WAIT = 500MSEC)	0	1	0
BYPASS (WAIT = 10 MSEC)	0	0	1

Figure 8-9. A9 Active Filter PCB Assembly (cont)

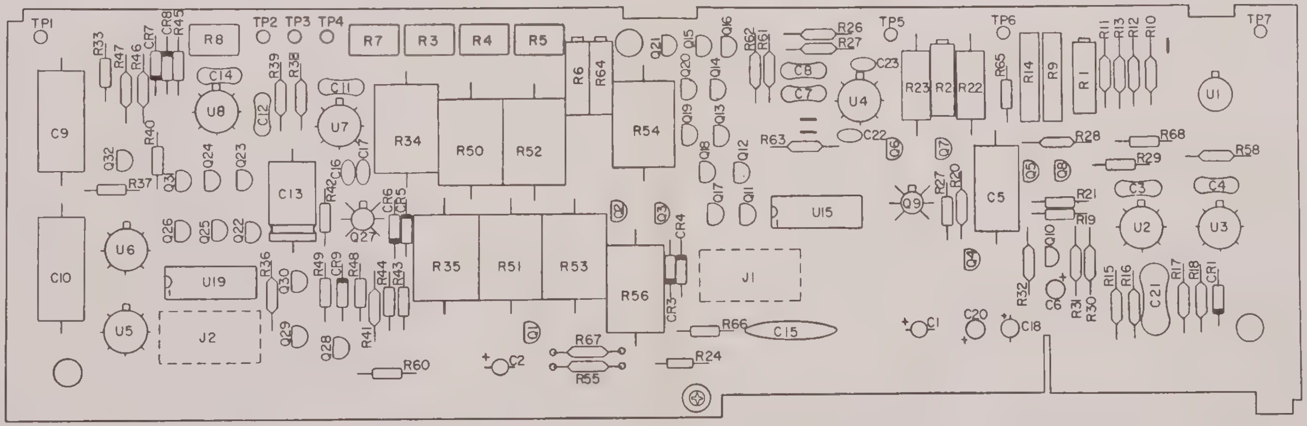

TP1
R33
R47
R46
CR7
CR8
R45
R8
TP2
TP3
TP4
R7
R3
R4
R5
R6
R64
Q21
Q15
Q16
R62
R61
R26
R27
TP5
TP6
R11
R13
R12
R10
TP7
C14
U8
R39
R38
C11
C12
U7
C9
R40
Q32
Q24
Q23
R34
R50
R52
R54
Q20
Q14
Q19
Q13
C8
C7
C23
U4
C22
R63
R23
R2
R22
R65
R14
R9
R1
U1
R28
R68
R58
R29
R37
Q31
C13
C16
C17
R42
CR6
CR5
Q27
Q18
Q12
Q17
Q11
Q6
Q7
Q5
Q8
Q9
R27
R20
C5
C3
C4
R21
R19
U2
U3
Q26
Q25
Q22
U6
Q2
Q3
CR4
U15
Q10
C10
U19
R36
Q30
R49
CR9
R48
R44
R43
R35
R51
R53
R56
J1
Q4
R32
C6
R31
R30
R15
R16
C21
R17
R18
CR1
U5
J2
Q29
Q28
R41
Q1
CR3
R66
C15
C1
C20
C18
R67
R55
C2
R24
R60

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Figure 8-10. A10A1 A/D Analog PCB Assembly

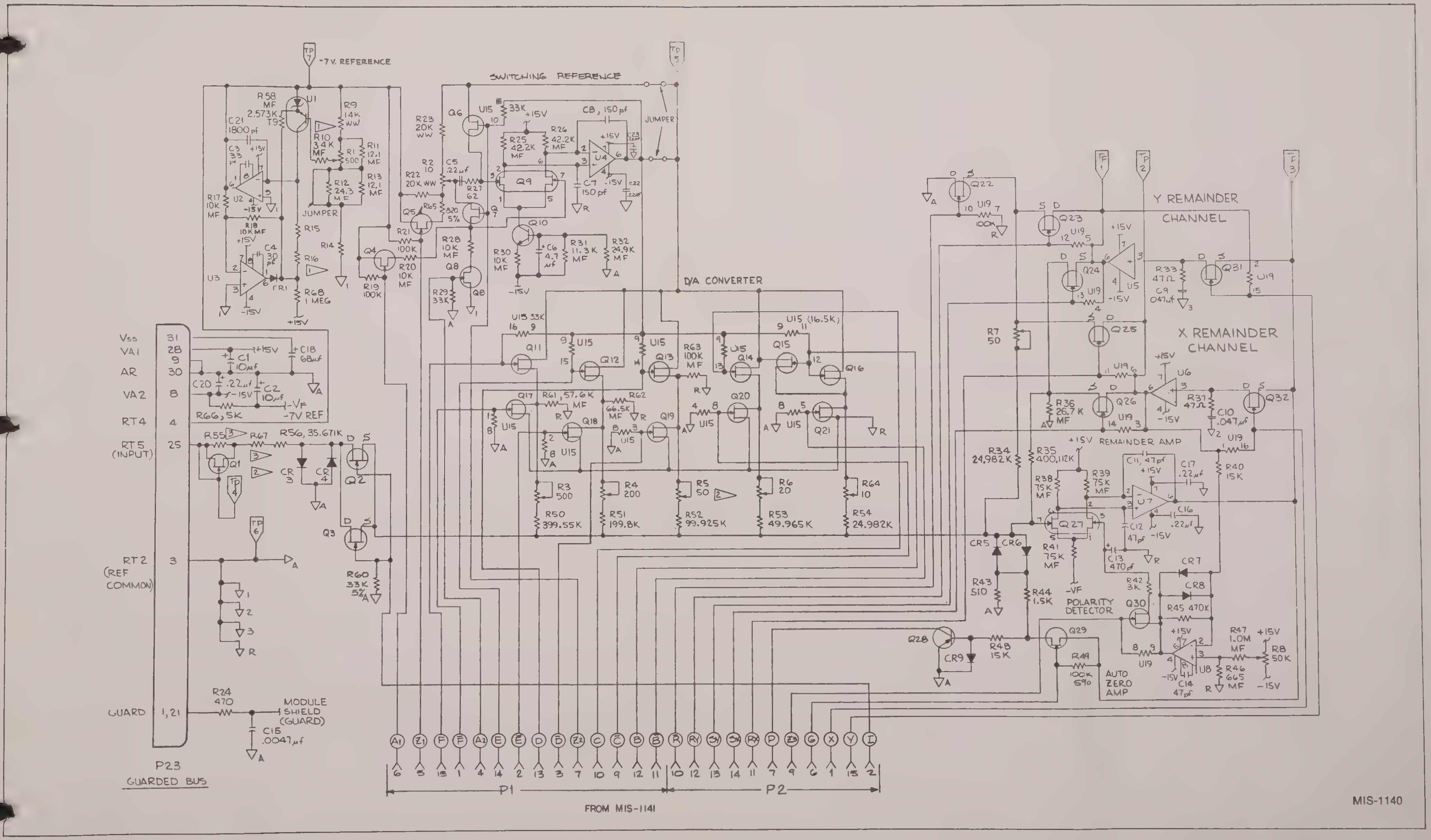
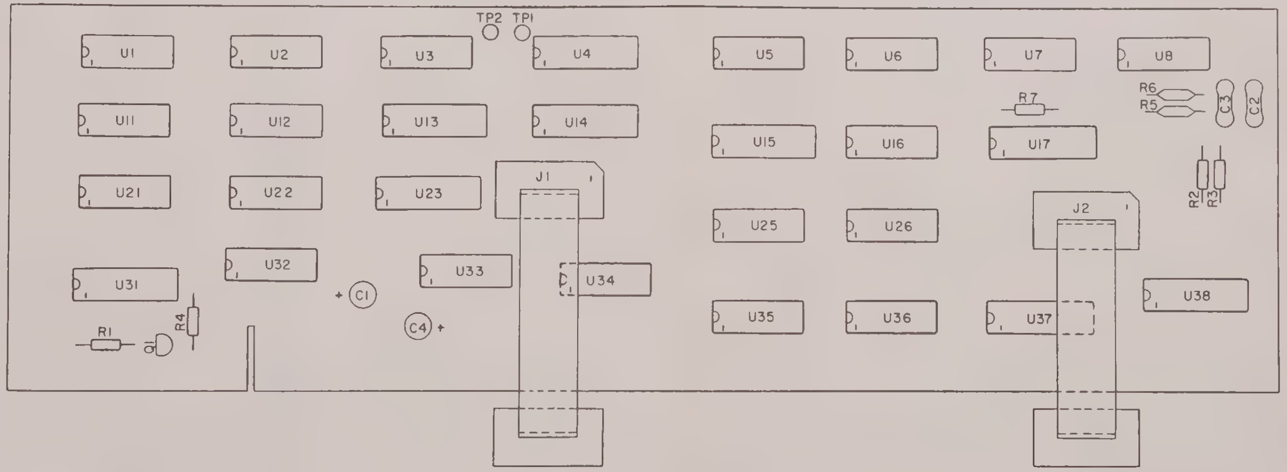
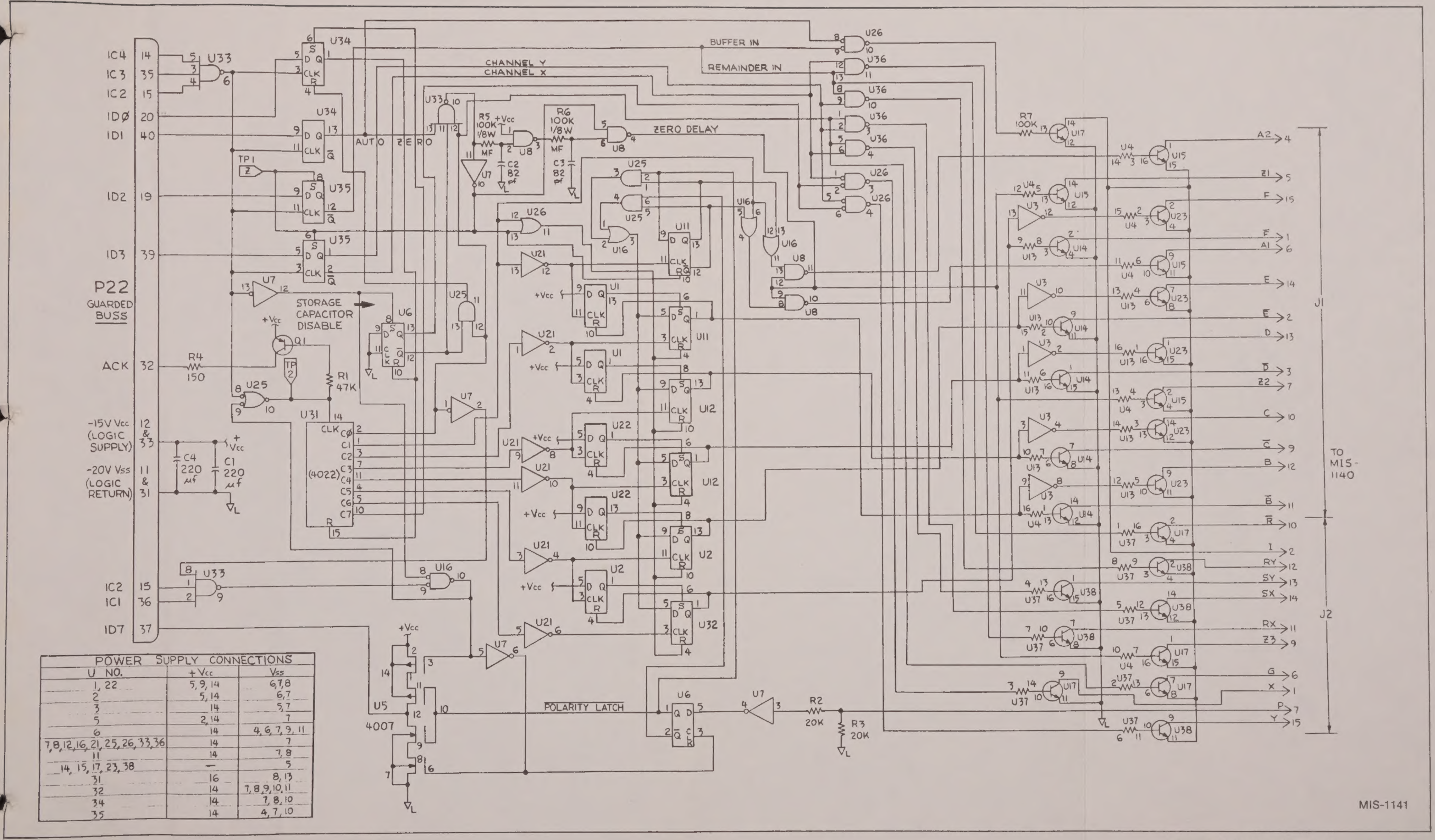

-7V. REFERENCE
SWITCHING REFERENCE
JUMPER
D/A CONVERTER
Y REMAINDER CHANNEL
X REMAINDER CHANNEL
REMAINDER AMP
POLARITY DETECTOR
AUTO ZERO AMP
Vss 31
VA1 28
9
AR 30
VA2 8
RT4 4
RT5 (INPUT) 25
RT2 (REF COMMON) 3
GUARD 1,21
R24 470
MODULE SHIELD (GUARD)
C15 .0047μf
P23
GUARDED BUS
R58 MF 2.573K
R9 14K WW
R10 3.4K MF
R1 500
R11 12.1 MF
R12 24.3 MF
R13 12.1 MF
C21 1800pf
R17 10K MF
R18 10K MF
R68 1 MEG
R23 20K WW
R22 20K WW
R2 10
C5 .22μf
R27 62
R65 820 5%
R25 42.2K MF
R26 42.2K MF
C8, 150pf
C7 150pf
R21 100K
R20 10K MF
R19 100K
R28 10K MF
R29 33K
R30 10K MF
C6 4.7μf
R31 11.3K MF
R32 24.9K MF
C1 10μf
C18 68μf
C2 10μf
C20 .22μf
R66, 5K
-7V REF
R55
R67
R56, 35.671K
R60 33K 5%
R61, 57.6K MF
R62 66.5K MF
R63 100K MF
U15 (16.5K)
R3 500
R4 200
R5 50
R6 20
R64 10
R50 399.55K
R51 199.8K
R52 99.925K
R53 49.965K
R54 24.982K
R7 50
R33 47Ω
C9 .047μf
R36 26.7K MF
R37 47Ω
C10 .047μf
R34 24.982K
R35 400.112K
R38 75K MF
R39 75K MF
R40 15K
C11, 47pf
C17 .22μf
C16 .22μf
C12 47pf
R41 75K MF
C13 470pf
R42 3K
R43 510
R44 1.5K
R45 470K
R47 1.0M MF
R8 50K
R46 665 MF
C14 47pf
R48 15K
R49 100K 5%
Q1 Q2 Q3 Q4 Q5 Q6 Q8 Q9 Q10 Q11 Q12 Q13 Q14 Q15 Q16 Q17 Q18 Q19 Q20 Q21 Q22 Q23 Q24 Q25 Q26 Q27 Q28 Q29 Q30 Q31 Q32
U1 U2 U3 U4 U5 U6 U7 U8 U15 U19
CR1 CR3 CR4 CR5 CR6 CR7 CR8 CR9
TP7 TP5 TP1 TP2 TP3 TP4 TP6
A1 Z1 F F A2 E E D D Z2 C C B B R RY SY SX RX P Z3 G X Y I
6 5 15 1 4 14 2 13 3 7 10 9 12 11 10 12 13 14 11 7 9 6 1 15 2
P1
P2
FROM MIS-1141
MIS-1140

Figure 8-10. A10A1 A/D Analog PCB Assembly (cont)


TP2
TP1
U1
U2
U3
U4
U5
U6
U7
U8
R6
R5
R7
C3
C2
U11
U12
U13
U14
U15
U16
U17
J1
J2
R2
R3
U21
U22
U23
U25
U26
U32
U33
U34
U31
C1
C4
U38
U35
U36
U37
R1
R4
Q1

MIS-1741

Figure 8-11. A10A2 Fast RR A/D Converter
Digital PCB Assembly


P22
GUARDED BUSS
IC4 14
IC3 35
IC2 15
IDØ 20
ID1 40
ID2 19
ID3 39
ACK 32
-15V Vcc (LOGIC SUPPLY) 12 & 33
-20V Vss (LOGIC RETURN) 11 & 31
IC2 15
IC1 36
ID7 37
U33
U34
U35
U7
U25
U6
U31
(4022)
Q1
TP1
TP2
R4 150
R1 47K
C4 220 µf
C1 220 µf
+Vcc
STORAGE CAPACITOR DISABLE
AUTO ZERO
CHANNEL Y
CHANNEL X
R5 100K 1/8W MF
C2 82 pf
R6 100K 1/8W MF
C3 82 pf
ZERO DELAY
BUFFER IN
REMAINDER IN
U26
U36
U8
U16
U11
U21
U1
U12
U22
U2
U32
U5
4007
POLARITY LATCH
R2 20K
R3 20K
R7 100K
U17
U4
U15
U3
U13
U14
U23
U37
U38
A2
Z1
F
F̄
A1
E
Ē
D
D̄
Z2
C
C̄
B
B̄
R̄
I
RY
SY
SX
RX
Z3
G
X
P
Y
J1
J2
TO MIS-1140
MIS-1141

POWER SUPPLY CONNECTIONS		
U NO.	+Vcc	Vss
1, 22	5, 9, 14	6,7,8
2	5, 14	6,7
3	14	5,7
5	2, 14	7
6	14	4, 6, 7, 9, 11
7,8,12,16, 21, 25, 26, 33, 36	14	7
11	14	7, 8
14, 15, 17, 23, 38	—	5
31	16	8, 13
32	14	7, 8, 9, 10, 11
34	14	7, 8, 10
35	14	4, 7, 10

Figure 8-11. A10A2 Fast RR A/D Converter Digital PCB Assembly (cont)